

Interactive comment on “Modeling the impacts of diffuse light fraction on photosynthesis in ORCHIDEE (v5453) land surface model” by Yuan Zhang et al.

Anonymous Referee #2

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This manuscript led by Zhang presented a study on improving the ORCHIDEE land surface model with specific consideration of the impacts of diffuse light fraction on vegetation photosynthesis, a well recognized phenomenon but poorly represented in the existing version of ORCHIDEE model. The new model, named after ORCHIDEE_DF, has included a scheme for partitioning light into direct and diffuse components, and separated the existing multi-layer canopy into sunlit and shaded leaves with a two-stream radiative transfer model following Spitters 1986. Then the authors used global fluxnet observations to evaluate the new model and found that the new model better simulates GPP under different illumination conditions. Examinations on the effects of diffuse light on GPP and light use efficiency and the interactions between diffuse light

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and other environmental factors such as temperature and vapor pressure deficit were conducted. The new model is suggested to have great potential in investigating aerosol effect on global biogeochemical cycles.

Overall the manuscript is very well organized and written, and easy to read. The description of the model development is clear, and the evaluation strategy is comprehensive and convincing. The analyses sections provide insightful understanding of the interactions of diffuse light and environmental factors. I don't really have much to add, but here I provide some minor suggestions and hope they can help further improve the quality of the manuscript.

1. Line 42-43: "However, this effect remains poorly represented in current land surface models". This is not accurate, at least CLM (Oleson et al., 2013), JULES (Mercado et al., 2009), CoLM (Dai et al 2004), iTem (Chen et al., 2014), and YIBs (Strada et al., 2016) have included processes that account for the diffuse light effect.

Oleson, K., Lawrence, D. M., Bonan, G. B., Drewniak, B., Huang, M., Koven, C. D., ... Yang, Z. -L. (2013). Technical description of version 4.5 of the Community Land Model (CLM) (No. NCAR/TN-503+STR). doi:10.5065/D6RR1W7M Mercado LM, Bellouin N, Sitch S, et al. Impact of changes in diffuse radiation on the global land carbon sink. *Nature*. 2009;458(7241):1014-1017. doi:10.1038/nature07949 Dai, Y., R. E. Dickinson, and Y. Wang, 2004: A Two-Big-Leaf Model for Canopy Temperature, Photosynthesis, and Stomatal Conductance. *J. Climate*, 17, 2281–2299 Min Chen & Qianlai Zhuang (2014) Evaluating aerosol direct radiative effects on global terrestrial ecosystem carbon dynamics from 2003 to 2010, *Tellus B: Chemical and Physical Meteorology*, 66:1, DOI: 10.3402/tellusb.v66.21808 Strada, S. and Unger, N.: Potential sensitivity of photosynthesis and isoprene emission to direct radiative effects of atmospheric aerosol pollution, *Atmos. Chem. Phys.*, 16, 4213–4234, <https://doi.org/10.5194/acp-16-4213-2016>, 2016.

The first three have been introduced in the paragraph of Line 88-100, but latter two

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were directly applied for examining aerosol impacts and should be discussed as well.

2. I would suggest the authors provide a table of acronyms in Section 2.1.2 and 2.1.3 as an appendix so that the readers are easier to follow the equations.

3. Section 4.2 discussed factors affecting response of GPP to diffuse light and the authors suggested that the lower temperature and VPD may be the main cause of the higher midday GPP under cloudier conditions. Does ORCHIDEE simulate leaf temperature at different canopy layers? If not, it is not very convincing to me, as the short-term air temperature and VPD variations are mainly determined by the meteorological system, rather than the radiation regime.

4. Section 4.3. I think another important limitation of the developed ORCHIDEE_DF model for examining aerosol impacts is that it does not consider the impacts of the changing radiation regime on leaf temperature. This might be a second-order effect, but could be potentially important as shown in Chen and Zhuang, 2014 Tellus B.

Anyways, this is an excellent study and I recommend publish it with addressing the above minor points.

Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2020-96>, 2020.

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