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Comment on acp-2021-641

Anonymous Referee #1

Referee comment on "Biogeochemical and biophysical responses to episodes of wildfire smoke from natural ecosystems in southwestern British Columbia, Canada" by Sung-Ching Lee et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-641-RC2>, 2021

Sung-Ching Lee et al. "Biogeochemical and biophysical responses to episodes of wildfire smoke from natural ecosystems in southwestern British Columbia, Canada"

GENERAL:

This paper explored the impacts of wildfire smoke on environmental variables and terrestrial productivity using long-term observations from both forest and wetland sites, and found moderate smoke promotes plant productivity via diffuse fertilization effects (DFE) but negative effects under dense-smoke conditions. Overall, this work is interesting and shows the significant impacts of diffuse radiation on ecosystem productivity. However, there are some important limitations need to be overcome before the publication in *ACP*.

First, this paper neglected necessary comparisons of DFE with other studies. Smoke aerosols can increase diffuse radiation and enhance gross primary productivity (GPP). The magnitude of such DFE should be compared with previous studies, such as Hemes et al. (2020) or Zhou et al. (2021). Such quantification can help explore the contributions of DFE to site-level GPP under different smoke episodes and for varied vegetation types.

Second, this paper had explored the changes of temperature, relative humidity, and other environmental factors caused by smoke aerosols, but did not consider the impacts of these changes of meteorology on GPP. I suggest that the authors consider impacts of other factors besides diffuse radiation using some statistical methods (e.g., simple linear regression used in Cheng et al. (2015)). The explorations of other environmental factors

are important especially for temperature and humidity, because smoke aerosols can largely influence them as shown in Figure 3.

Third, this study needed better explanations of their findings. For example, why the changes of PM_{2.5} and AOD in Figure 2 are not corresponding to each other. The high AOD in 2017 was associated with low PM_{2.5} while the high PM_{2.5} in 2020 was associated with low AOD. How such inconsistency affected the impacts of fire smoke on plant photosynthesis? Furthermore, there are some differences in the responses of meteorology as shown in Fig. 3. Why the RH was higher during smoke days for forest site in 2020 but was lower in other years? Also, section 3.1.2 discussed the changes in energy fluxes but did not explain why the responses of H and LE were different in different years.

Finally, the authors needed to exclude other associated perturbations such as cloud and ozone. As shown in Figure S2, the site-level observations show large reductions in surface shortwave radiation during some non-smoke days. Such reductions are likely caused by cloud. Previous studies found that cloud could mask the positive effects of aerosol DFE (Yue and Unger, 2018). So it is not reasonable to compare the smoke and non-smoke days, which is defined as all the remaining days in the same month (Line 288), because the sky conditions between fire and non-fire days could be different. The authors need to redo their analyses based only on clear-sky days to exclude the cloud effects. Meanwhile, fires can cause large enhancement of ozone, which can decrease GPP. Such effects are not considered in this study and need to be discussed about their possible impacts on final conclusions.

SPECIFIC

Abstract: This section needs to explain which processes in this study are biogeochemical and which are biophysical.

Line 23: H and LE should be explained at the first appearance.

Line 267: Is this formula of diffuse fraction applicable for the two sites in this study?

Figure 6: Although the relationships between LUE, PAR and diffuse fraction had been

explored in this figure, I suggest that the relationships between GPP and diffuse fraction should be shown and compared with previous studies.

Reference:

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Hemes, K. S., Verfaillie, J., and Baldocchi, D. D.: Wildfire-Smoke Aerosols Lead to Increased Light Use Efficiency Among Agricultural and Restored Wetland Land Uses in California's Central Valley, *J Geophys Res-Bioge*, 125, 10.1029/2019jg005380, 2020.

Yue, X., and Unger, N.: Fire air pollution reduces global terrestrial productivity, *Nature Communications*, 9, 10.1038/s41467-018-07921-4, 2018.

Zhou, H., Yue, X., Lei, Y., Zhang, T., Tian, C., Ma, Y., and Cao, Y.: Responses of gross primary productivity to diffuse radiation at global FLUXNET sites, *Atmos Environ*, 244, 117905, 10.1016/j.atmosenv.2020.117905, 2021.