

## ***Interactive comment on “Aerosol pollution radiative effects on land carbon uptake in China” by Xu Yue and Nadine Unger***

**Anonymous Referee #2**

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### **1 Overall assessment and general comments**

In this manuscript, focusing on China, the authors apply a process-based vegetation model and a column radiative model (CRM) to regionally assess the effects of present-day aerosol loading on Net Primary Productivity (NPP). By performing sensitivity studies under different aerosol optical depth (AOD), the authors estimate two AOD thresholds that (1) leads to maximum NPP ( $AOD_{t1}$ ) and (2) always enhances local NPP ( $AOD_{t2}$ ). This original estimate provides a tool to evaluate the possible impact an increase/decrease in the regional aerosol loading may have on the land carbon uptake. In their assessment, the authors account as well for the role of clouds, compared to aerosols, in the diffuse fertilization effect (DFE) by analyzing both clear-sky and all-sky conditions in the model output.

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The paper examines an important topic such as the aerosol DFE, and addresses relevant scientific questions over a region critical for air pollution studies. Hence, the paper is within the scope of ACP. The abstract is concise and complete, the paper is well written, the methods and modeling are well laid out, the literature is thoroughly referenced, and the results are presented in good clear figures, with an appropriate use of supplementary materials. Overall, I recommend publication after a few minor comments, listed below, have been answered by the authors. In particular, I would suggest the authors to make the title more precise, and to better outline the originality of the developed method (i.e., AOD thresholds) and how this may provide a useful tool for better understanding the role of aerosols in the DFE.

### **2 Specific comments**

#### **Sect. 1, Introduction**

Introduction is exhaustive, clear and has a right length. I found Table 1 a very good state-of-the-art on observational studies of cloud and aerosol DFE. Regarding Table 1, may I suggest the authors to account for the following observational studies that focus on cloud DFE?

- “Variations in the influence of diffuse light on gross primary productivity in temperate ecosystems”, Cheng et al., *Agricultural and Forest Meteorology*, 2015.
- “Using satellite-derived optical thickness to assess the influence of clouds on terrestrial carbon uptake”, Cheng et al., *Journal of Geophysical Research*, 2016.

**Pag. 4, ll. 91:** “Our model approach offers a large regional scale assessment ...” It’s not clear to me the reason why the Mercado et al.’s study is cited at the end of the this sentence. Could you please clarify this sentence to me?

C2

## Sect. 2, Methods

Methods are clearly outlined. To allow the traceability of results, I think it is important to provide details on the time and spatial scale of used dataset (e.g., FLUXNET and MODIS) and as well the MODIS products that have been used (e.g., MODIS Terra and/or Aqua? Original time and spatial scale of MODIS product? Which MODIS product?).

**Pag. 8, Il. 217:** “The simulated PAR is alternately applied ...” It’s not clear to me the use of the adverb “alternately” in this sentence. Could you please clarify this sentence to me?

## Sect. 3, Results

Pag. 10, Il. 287–289: The authors state that “Introduction of aerosol pollution to this system ... thus increasing the LUE and GPP of the whole canopy.” I’m not sure if this sentence refers to the behaviour of GPP at DF lower or greater than 0.55. As I look at Fig. 4, if I understand correctly, the DF enhances under an increasing aerosol loading. For clear-sky conditions (red empty points) at diffuse fraction (DF) < 0.55, I can clearly see that GPP enhances as DF increases. However, at DF > 0.55, it’s not easy to understand the effects a further introduction of aerosols has on GPP. Could the authors make this point clearer to me?

**Pag. 10, Il. 291–292:** “... for shrub, ... for C3 herbs, and ... for C4 herbs”. It’s not clear to me if “shrub” includes as well the tundra PFT (as seems to be stated further in the text, pag.11, Il. 311), or if this PFT has been discarded for analysis. May I suggest to specify as well PFTs included under “C3/C4 herbs”?

**Pag. 12, Il. 363–367:** “Over the North China Plain and the Southwest, ... relative to aerosol-free conditions.” Many of the results discussed here seemed to refer to contrasting magnitudes over selected regions. However, when I consult Fig. 7 by myself, trying to corroborate the statements, in some cases I couldn’t find the same

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conclusions. For example: over the North China Plain, current AOD levels seem to me lower than  $AOD_{t2}$  during summer. I also have trouble in validating conclusions over southeastern coastal regions, where it seems to me that observed AOD is lower than both  $AOD_{t1}$  and  $AOD_{t2}$  (and not “lower than  $AOD_{t2}$  but close to  $AOD_{t1}$ ”). Am I misinterpreting the plots (Fig.7b and d)? Maybe, stating some of the actual values could help the reader in consulting these plots.

**Pag. 13, Il. 372–374:** Concerning Fig. 8, I found interesting that under both clear-sky and all-sky conditions, changes in summer NPP are very small ( $\sim 0 \text{ gC m}^{-2} \text{ day}^{-1}$ ) over the North China Plain, although this region shows the highest levels of summer AOD (Fig. 3). Is it possible to provide an explanation of results in Fig. 8 based on Fig. 7? In my opinion, results presented in Fig.8 should be better contextualized in the whole study.

## 3 Minor comments

**Abstract - Pag. 2, Il. 23:** Definition of the acronym DFE is missing in the abstract (latter defined in the main text, pag. 3, Il. 47). Please insert a definition in the abstract.

### Sect. 1, Introduction

**Pag. 3, Il. 46:** To establish common ground with readers, may I suggest to add a short definition of LUE (e.g.,  $GPP/PAR$ )?

**Pag. 3, Il. 72:** “and the plant species” Again, to establish common ground with readers, I think it would be useful to briefly precise some plant features that influence the DFE.

**Pag. 4, Il. 76:** “Observations suggest that both cloud and aerosols exert ...”, I think an “s” is missing in “cloud”.

## Sect. 2, Methods

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**Pag. 5, ll. 117:** Definition of the acronym PFT is missing. Please define it.

**Pag. 5, ll. 136:** May I suggest to specify here that the CRM model needs aerosol profiles and meteorological re-analyses to calculate “reflectivity and transmission of atmospheric layers ...”? As already done by the authors, the applied aerosol profiles and meteorological re-analyses will be specified later.

**Pag. 6, ll. 149:** “The model utilizes ...” may I suggest to precise “the CRM model”?

**Pag. 8, ll. 230:** “We then select sites that all months are available ...”, I think “that” should be replaced with “where”.

### **Sect. 3, Results**

**Pag. 10, ll. 277:** “. . . because lower cloud coverage there allow larger ...” I think an “s” is missing in “allow”.

**Pag. 11, ll. 328:** “. . . both cloud and aerosols exert ...” I think an “s” is missing for “cloud”.

### **Sect. 4, Discussion and conclusions**

**Pag. 13, ll. 387–388:** “. . . available measurement and modeling results ...”: I think an “s” is missing in “measurement”.

**Pag. 13, ll. 390:** “. . . radiative transfer scheme, We apply ...” Replace comma with dot.

### **Sect. 2, Methods**

**Figures 1–3:** For completeness, I would suggest to insert a short explanation of what red and dashed lines represent.

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