

## ***Interactive comment on “Resource and physiological constraints on global crop production enhancements from atmospheric particulate matter and nitrogen deposition” by Luke D. Schiferl et al.***

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\*A note upfront from the submitting person: This review was prepared by Miriam Steinmann & Michelle Giust, two master students in geography at the University of Zurich. The review was part of an exercise during a second semester master level seminar on “the biogeochemistry of plant-soil systems in a changing world”, which I organize. We would like to highlight that the depth of scientific knowledge and technical understanding of these reviewers represents that of master students. We enjoyed discussing the manuscript in the seminar, and hope that our comments will be helpful for the authors.\*

C1

General comments: This comment was written when other comments were not available yet.

The goal of this study is to analyse the effects induced by an increase of atmospheric particulate matter (PM) and nitrogen (N) deposition on crop productivity on a global scale. Both these factors are expected to increase in future due to climate change. While there have already been studies on the effect of air quality on crop production, this study is interesting because it includes environmental (water and N stress) and physiological constraints which are responsible for a damped crop response and that have been neglected before. The authors added these new variables to an already existing model that combines global gases and particles concentrations, and meteorological data, along with soil and management informations.

Generally, the research questions are reasonable and important to address and the paper is well structured. Nonetheless, little pre-existing literature is included in the introduction and some parts of the paper. In addition, how the authors came to the results is not so clear to us yet. A short procedural part that explains the study approach in the introduction would for sure simplify the understanding for other readers that are not experts in the field, as we are. Confusing was also the fact that no discussion section was in between the results and conclusion section. In our opinion, the results could be more thoroughly discussed, they seem to just be presented but not explained or questioned. The reason for the spatial patterns of different rate of crop productivity is missing. The authors already wrote a paper in 2017 analysing the crop production of 2010, however they didn't consider physical and biological limitation. This new study tries to fill these gaps by including them in the model, therefore it refers to 2010 also. Since the analysed variables change year to year (e.g. water stress, which depends on precipitation (Page 6, Lines 7-8)), the authors should not make general assumption. Maybe re-formulate conclusion to include that all findings refer to 2010 and can differ for other years.

Specific comments:

C2

1. Page 1, Lines 26-28: If the global decline in crop yield is considered, shouldn't localized changes in factors be included in this globality and thus get evened out?
2. Page 2, Line 1: What do the authors mean with physiological limitations? Are only the numbers of kernels per plant considered? If yes, say so in the introduction.
3. Page 2, Line 4: Is PM as abbreviation for atmospheric particulate matter commonly done, or why is the "atmospheric" not included in this abbreviation?
4. Page 2, Lines 21-24: Sentences "By artificially fixing inert nitrogen gas [...]" and "Anthropogenic influences on these fluxes [...]" are very similar, the second one could be left out.
5. Page 2 onwards: Abbreviation N for nitrogen introduced on line 21, still nitrogen is very often fully written in the following pages, but not always. Consistency?
6. Page 2, Lines 26-27: It's difficult for me to imagine that there are lot of N-poor regions in the world. Which areas are N-poor? Which not? Do these areas show different results in regard to change in productivity? Or does having too much N also count as N stress?
7. Pages 3-5: The explanation of the models used is confusing. The section includes many acronyms, sometimes explained other times not. We think the rule "less is more" is true for this section. The information should be available if a reader wants it, but should be written in a simplified way in the paper to get a clear idea of the approach used.
8. Page 4, Lines 5-6: It is unclear to us what is meant with v4.6 and v2.0, is their meaning considered common knowledge? If not, please explain
9. Page 5, Lines 2-3: We wonder why the equation for the potential carbon production for maize and wheat is different in respect to the equation for rice. An explanation should be added.

### C3

10. Page 5, Lines 25-26: It seems confusing to focus the figures on the northern hemisphere but still include global values. Either show a global map or add a sentence about why you only focus on the northern hemisphere.
11. Page 6, Line 31: What is entailed in the offline relativistic methodology? Add short explanation. Also why is it referred to here instead of the base simulation?
12. Page 7, Lines 4-6: The increase in maize production is much lower with PM in respect to rice or wheat. A reason for that seem to be the number of kernels. Then why for rice and wheat not? Why only US considered? Where is the literature? Why add 500 extra kernels and to which plant (550 kernels vs. 900 kernels) are they added? Why 500, seems arbitrary? Also, results are never discussed again and not included in the conclusion, while the other parameters (water & N stress) are compared.
13. Page 7, Lines 23-24: "[...], production due to also PH increases, [...]" bad syntax, rewrite
14. Page 7, Line 27: Why are no PM effects considered in relation to N deposition? Wouldn't this comparison make sense as both effects are found together and connected to each other in reality?
15. Page 8, Lines 15-19: How were these 30 days decided upon if the duration of deposition has such a large impact on crop production? Especially as it is stated in lines 10-11 that "[...] the length of time nitrogen is retained in the soil and useful to the plant is uncertain.", making an explanation of the chosen time period even more important. Unclear, elaborate.
16. all figures except Fig. 4: Color scheme unsuitable for black/white printing, maybe use white background (maps) and grayscale for scale? Also the numbers and description are too small and too close to the scale to be well legible.
17. Figure 1: Are the 2 stresses separately really necessary? They are not considered separately again later? Please avoid rainbow colour scales in your figures. See

### C4

<http://rdcu.be/dWCF> for a brief discussion of problems associated with these scales, and for suggestions for alternatives.

18. Figure 4: The results displayed in this figure can all be found in the other figures as well, in relation to their spatial distribution, which makes more sense in this case. Is this figure needed at all? Why is the comparison done with the offline analysis and not the base simulation?

19. Figure 5: Are “No PM” and “With PM” needed, aren’t the Delta-values enough? There is a bracket missing before “[. . .], middle column).

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C5