Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2018-114-RC2, 2018

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.

Anonymous Referee #2

Received and published: 18 April 2018

This paper represents an innovative advance in the interdisciplinary research area of air pollution impacts on global food production through linking the global aerosol model (GEOS-Chem) to a crop modeling framework (pDSSAT). The study is "part 2" follow-up of a recent paper accepted for publication: Schiferl, L. D. and Heald, C. L, Particulate matter air pollution offsets ozone damage to global crop production, Atmos. Chem. Phys. Discuss., 2018. AgMIP has not traditionally assessed air pollution impacts on crops so this study is a welcome addition to the literature. The paper is brilliantly written and all figures and graphs are suitable for Biogeosciences.

1. There is already extensive integrated research on air pollution impacts on crops and plants. For example, flux-based risk maps e.g. Mills et al., Global Change Biology, 2011. Much of this line of work already integrates physiological constraints holistically.

2. It is difficult to understand how a crop model that does not consider water stress can be useful, or even exist in the published literature? Why was pDSSAT chosen for the study? There are process-based crop models available e.g. GLAM. Moreover, international process-based vegetation models, for instance CLM and JULES, now include crop functional types that will inherently account for water limitation. Perhaps I have misunderstood something here. Crops are very sensitive to water availability.

3. Following from point (2), it is concerning that the first paper did not include any limitation on the diffuse radiation fertilization of crops. For example, any process-based model that incorporates Farquhar-Ball-Berry photosynthesis-stomatal conductance equations will automatically include limitations on the diffuse radiation fertilization e.g. Yue and Unger, Aerosol optical depth thresholds as a tool to assess diffuse radiation fertilization of the land carbon uptake in China, ACP, 2017.

4. The aerosol and crop models have very different horizontal resolution. The aerosol model is fairly coarse (2degx2.5deg). How is the aerosol radiation output downscaled for the high resolution crop model?

5. How does pDSSAT calculate growth, biomass and yield from the potential carbon?

6. It appears that only the direct radiation changes of aerosols are calculated in GC_RT? How do aerosol indirect effects (aerosol-cloud interactions) influence the results and conclusions? Aerosol indirect radiative effects are widely accepted to be larger than the direct effects.

7. The paper is lacking in any observational evidence and as such is a theoretical modeling study. Other studies have attempted to present observational evidence e.g. Strada and Unger, Observed aerosol-induced radiative effect on plant productivity in

the eastern United States, Atmos Env 2015 and references therein; Strada and Unger, Potential sensitivity of photosynthesis and isoprene emission to direct radiative effects of atmospheric aerosol pollution, ACP, 2016; Yue et al., Future inhibition of ecosystem productivity by increasing wildfire pollution over boreal North America, ACP, 2017. One basic question is: do agricultural workers report that crops grow better and yield is higher under hazy and cloudy conditions?

8. Aerosol radiation changes will impact meteorology and hydrology (esp. temperature and soil moisture). These impacts likely have a much larger effect on crop productivity than the light changes e.g.: Yue et al., Ozone and haze pollution weakens net primary productivity in China, ACP, 2017. Is it possible that the light change impacts are over-estimated in the current approach? For instance, an 11% enhancement in global wheat would have major impacts on global economics.

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2018-114, 2018.