Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC2
https://doi.org/10.5194/acp-2021-701-RC2, 2021

Comment on acp-2021-701

Anonymous Referee #2

Referee comment on "Distinguishing the impacts of natural and anthropogenic aerosols on global gross primary productivity through diffuse fertilization effect" by Hao Zhou et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-701-RC2, 2021

Review of "Distinguishing the impacts of natural and anthropogenic aerosols on global gross primary productivity through diffuse fertilization effect" by Hao Zhou et al.

General comments:

This study used the GEOS-Chem chemistry transport model, combined with the CRM radiation model and the Yale Interactive terrestrial Biosphere (YIBs) model to quantify the impact of 2001-2014 global aerosol distributions on gross primary productivity via the diffuse radiation fertilisation effect. The paper addresses an interesting topic and could bring an important contribution to existing literature in this area. However, in my opinion it still requires some important revisions before it can be published.

Major comments:

- Quantifying the uncertainty of the estimates presented. While Section 4.2 does acknowledge the limitations and uncertainties of the study, more should be done to quantify the effect of these uncertainties on the calculated changes in radiation and GPP. For example, how does the underestimation of simulated AOD compared to MODIS (e.g. Fig. S1) affect the calculated changes in GPP (i.e. error bars on the 0.95

Pg C yr-1 estimate for GPP increase caused by aerosol diffuse radiation fertilisation)? And, in particular, what is the effect of the reported substantial bias in some key regions such as the Amazon, central Africa and boreal Asia (lines 413-415)?

- Linearity of all simulated effects. Figure 1 indicates a highly non-linear GPP to PAR response. Nevertheless, all results presented show the opposite, with linear responses for both the PAR to aerosol loading response (e.g. Fig. 2, Fig. S3), and for the GPP to aerosol loading response (e.g. Fig. 3, Fig S6). This should be discussed and clearly justified.
- While the structure of the paper is relatively clear, I found it quite hard to follow the argument in some cases. I suggest a careful rewrite of some of the results paragraphs, with a more clear highlight of the main results presented. Also, to improve readability of the paper, some figures from the supplementary material might be better suited in the main manuscript.

Specific comments:

- How do the aerosol induced changes in PAR compare with other published results? How realistic are the results presented in Figures 2 and 3? For example the large areas with virtually zero aerosol effect on diffuse PAR (e.g. South America, Australia, large parts of Europe, Northern Asia).
- More details should be provided for the evaluation of the CRM radiative transfer model. What causes the differences in simulated and observed clear-sky and all-sky SW fluxes presented in Figure S2 (i.e. a vs. b, d vs. e, a-d vs b-e), considering that both the model clouds (lines 147-149) and the SW fluxes used for validation (lines 203-205) are based on CERES SYN1deg observations?
- Should include a more thorough discussion of the implications and meaning of the various estimates presented under clear sky and under all sky conditions, rather than simply listing these values.
- Why is the 2003 difference between simulated all-sky GPP changes from natural and anthropogenic aerosols the smallest (Fig 5a), while the same difference under clear sky conditions seem to be the largest across all period (Fig 5b)?
- To better put these estimates into perspective, it would be very useful to also provide an estimate of the magnitude of other (non-included) aerosol effects, in particular the aerosol-induced changes in temperature? This could be done by performing an additional YIBs simulation driven by aerosol induced temperature changes estimated using existing aerosol transient climate sensitivity values.

Technical corrections:

- Line 180: “source” should be “sources”.
- Line 211: “normalize” should be “normalized”
- In various places (e.g. lines 24-25) “at clear skies” or “at all skies” does not read well and could be changed to e.g. “under clear sky conditions”.
- Clearly state how the standard deviation illustrated in Figure 5 was calculated.