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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Potential sensitivity of photosynthesis and isoprene emission to direct radiative effects of atmospheric aerosol pollution" *by* S. Strada and N. Unger

Anonymous Referee #2

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In this manuscript, the authors use a global chemistry-climate model coupled with a terrestrial biosphere model to test the sensitivity of plant productivity and isoprene emission to anthropogenic aerosol sources (due to their effect on the radiation flux at the Earth's surface). Their model results show that global land carbon fluxes may not be sensitive to anthropogenic aerosol pollution, but that the sensitivity can be regionally significant with interesting implications for climate and atmospheric chemistry. This is a novel investigation of potential feedbacks between anthropogenic pollution and the biosphere, and the results contribute substantively to the literature on biosphere-atmosphere interactions. This manuscript is well within the scope of ACP and will

certainly be of interest to its readers.

In general, the article is written sufficiently clearly, the methods and modeling are well laid out, the literature is thoroughly referenced, and the results are presented in ample figures and tables. I look forward to seeing this article published once the authors have addressed the following minor issues. Specifically, I think the authors could more clearly justify how the dominant mechanisms (light scattering vs. cooling vs. reduction in direct radiation) were identified over individual regions.

General Comments:

I found Sections 3.2.1 a bit difficult to follow. May I suggest treating the results for direct and diffuse radiation each alone in their own subsections/paragraphs, followed by a summary on the net impact on total radiation? Or alternatively, treat each region in their own separate subsections/paragraphs? In my opinion, this section could be refocused so that it's more consistent with what is important for understanding the results presented in Section 3.3.1 and 3.3.2. I was not convinced how the effects of cooling and scattering were unequivocally separated later in the manuscript, and I suspect that could be laid out more clearly in the presentation of results here.

I also had trouble being convinced of some of the regional comparisons that were being made. For example:

p. 25446, lines 5-6: It's unclear from Figure 4 that the eastern US shows much larger of an increase in diffuse radiation than over China for example (especially looking at panel (i)). This point seems important further on in the article, so I think it deserves further clarification.

p. 25446, lines 8-11: The authors state that biomass burning aerosol drive the decrease in several regions (in the range of -6 to -28 W m-2), but as I look at Figure 4 over the regions named, it seems to me that subtracting the industrial sources also result in decreases on the order of -6 to -12 W m-2 and larger. This seems especially

true when looking at the seasonal results in Figure S6. Am I misinterpreting the plots?

To pick up on this a little more, I also had some trouble with Section 3.3.1. Many of the conclusions here seemed to depend on contrasting the magnitude of certain effects over various regions. However, when I would try to corroborate the statements by consulting the Figures myself, in some cases the magnitudes didn't appear to be all that different. This might have to do with the Figures themselves, or maybe this could be improved by refocusing Section 3.2.1. In some cases, perhaps (re-?) stating some of the actual values would help. For example:

p. 25450, lines 4-8: I don't see from Figure 4 how the increase in diffuse radiation over the eastern US is that much larger than over China and parts of Europe (as I mentioned above). Moreover, it's not at all convincing from Figure 5 that SAT over the eastern US is "reduced". There is a very small isolated patch of blue, but there is no hatching anywhere to denote significance, and most of the region is blank. I'm also confused as to what is "contrary" about Europe and China experiencing a strong reduction in total and direct radiation. Panel 4a and 4b show the US experiences comparable decreases in total and direct radiation as for parts of Europe, and maybe China. Maybe part of this confusion can be clarified by better summary of the results of Figure 4 in Section 3.2.1?

p. 25450, lines 22-23: I can see from Figure 4 how it might be true that the increase in diffuse radiation over the Amazon is weaker than over central Africa – but it doesn't seem that different, either. As a matter of fact, Section 3.2.1 places the two regions in the same sentence within the same range... So it's not clear how the statement "the Amazon basin experiences a weaker increase in diffuse radiation" can be all that significant. Again, this might be helped by better structuring Section 3.2.1 to correspond to the conclusions being made here in Section 3.3.1 (and/or by referring to exact values over specific regions, for diffuse and direct radiation separately). Likewise, the "larger cooling" experienced by the Amazon basin compared to central Africa (Figure 5) doesn't appear notable to me either. In Panel 5a, they have roughly the same

amount of area that is hatched as significant. This statement seems important to their conclusions about how "cooling dominates in the Amazon basin", but as is, I think the authors need to do a better job showing that this is true.

p. 25451, lines 12-16: Again, given the results that have been presented, I'm not yet convinced that the different mechanisms for each region (light scattering over Eastern US; reductions in direct radiation in Europe and China; cooling in the Amazon Basin) could have been established from the present model results alone. In my opinion, the arguments leading up to this based on the present model results alone have not been clearly developed.

Specific Comments:

Section 2.1 p. 25441, line 2: Is there a particular reason that the Unger et al. 2013 ACPD article is being cited, when the ACP article is available?

Section 2.2 p. 25442, line 16: Can you state/show some of the IPCC values that you are referring to for comparison, so the reader can see how consistent the results here are?

p. 25442, line 23: This is certainly on the low end of the global isoprene emissions estimate. Could you comment on why this might be?

Sections 3.1.1 and 3.1.2 It's not clear to the reader how "consistent" the AOD and GPP results are with observations. While the Figures do a good job showing that the model can broadly reproduce some of the spatial patterns, could some quantifiable statistics from the comparisons be shared?

Section 3.2.1: p. 25445, lines 14-16: Should the authors clarify when they say "slightly affected" or "highly sensitive" that they are referring to the relative change (%)? The absolute magnitudes seem roughly equally considerable ($\sim$2-8 W m-2)

p. 25445, line 26: I think a word ("atmosphere"?) is missing between "aerosol laden" and "due to".

p. 25445, lines 25-27: These lines seem to essentially repeat statements from the immediately preceding paragraph (lines ∼12-14). Perhaps make it clearer that while the Table is global totals, Figure 4 shows the spatial distribution of the impacts.

p. 25446, line 17: Correct “of” to “for”.

Section 3.2.2 p. 25448, lines 14-15: An explanation for how the changes will be linked to SSR and SAT uniquely might be useful here.

Section 3.3.1 p. 25449, lines 24-27: The authors comment on how the impact is greatest for PFTs with complex canopy architectures. Maybe the evidence of this is found in the Figure, but this it’s not explained clearly. Please elaborate.

Section 3.3.3 p. 25453, line 19: “not sensitive” – Can you clarify how you’ve decided this? Do you mean that within 95% CI, there is no significant change?

p. 25454, lines 2: Insert a period between “US” and “This region. . .”

Section 4 p. 25454, line 23-24: I think the authors could include a brief comment about how aerosol pollution can drive plant phenology.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 25433, 2015.