Atmospheric Chemistry and Physics Discussions

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Comment on acp-2021-1068

Anonymous Referee #2

Referee comment on "Satellite soil moisture data assimilation impacts on modeling weather variables and ozone in the southeastern US – Part 2: Sensitivity to dry-deposition parameterizations" by Min Huang et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-1068-RC2, 2022

General comments

This manuscript assesses the influence of assimilating soil moisture observations on modeled ozone dry deposition using either a Wesely or dynamic scheme in two commonly used land surface models. They report a much stronger sensitivity to soil moisture within the dynamic scheme and assess how this affects health and ecological endpoints related to ozone damage. This is a novel approach that moves the science forward and fits well with the scope of ACP, although more evidence is needed for several of the conclusions. The model evaluation is not mechanistic and at times conflicts with conclusions drawn about the observational constraints. For example, biases are attributed to both the model and the soil moisture dataset in dense vegetation regions but without clear justification. There is a noticeable dearth of citations, both for previously established concepts and the datasets used, and the abstract could be sharpened to better reflect the key takeaways of this manuscript. With these major changes implemented, I believe that this paper may be ready for publication.

Specific comments

- For the abstract, please consider restructuring to introduce the main questions of the study before discussing the overall methods/findings, and to sharpen the latter part of the paragraph to clarify your findings (more specifically, after the sentence that ends with “due to the data assimilation (DA)”, which I found to be quite strong and nicely written). I found the phrases “strongly affect the quantitative results” and “wide range below 20%” to be a bit vague and a bit of a missed opportunity to express your key takeaways.
- Lines 43-44: Please change the word “ever-tightening” to something like “tighter.” It is not a given that air quality standards will continue to be more stringent.
- Line 46: Please include more of the pertinent references here rather than only citing

the companion paper.

- Line 48: For the sentence that ends "deposited chemicals' concentrations", please consider citing Baublitz et al. 2020.
- Lines 79-end of paragraph: Specify which of the preceding references compare Wesely parameterizations (e.g. Wong et al. 2019, Wu et al., 2018) and factor of 2 differences (e.g. Clifton et al. 2017).
- Line 125 – Consider mentioning that these schemes will be described in section 2.3.
- Paragraph starting at line 187 – It's not clear how this connects with the focus of your paper. Please consider cutting this paragraph or expanding on relevant connections.
- 281-282 – More information is needed about this extrapolation as it's not immediately clear this is justified/warranted. Is the 13 day period in the middle of the extrapolation? How are you accounting for seasonal effects on ozone? How does the seasonal cycle of vegetation (and vd) compare with the seasonal cycle of ozone, and how are you accounting for the differences?
- Lines 316-317 – a nice finding about the wet/dry biases by forest coverage
- Lines 323-324 – What was the r value before? What is the implication of the increase?
- Sentence starting on line 336: "The likely degraded model performance…" What evidence do you have that the SM-vegetation growth feedbacks contribute the model bias? Later (lines 352-354) it's suggested that dense vegetation challenges SM DA, but here the DA seems to be assumed to be true. Consider providing more evidence for your claim and/or providing context for DA uncertainty.
- Please provide citations for the sentence starting line 352: "The EF values were unfavorably reduced… in previous studies." What studies?
- Paragraph starting at line 363: The SIF results are compelling and support your prior analysis. It's not as clear how the OCS component relates to your investigation. This paragraph is also oddly positioned in that it interrupts the EF discussion. Consider re-structuring it and connecting the OCS component back to previous discussion. Alternatively, cut the OCS analysis and incorporate the SIF component as a sentence or two in the previous paragraph.
- What is the timeframe for the ACT-AMERICA campaign? A figure caption states 2016, but this paragraph is talking about 2004 … ? I'm finding it challenging to follow this part of the analysis.
- Lines 405-406: "results from many existing model- and measurement-based studies" needs citations.
- Lines 539-541 – Please expand on the evidence for your conclusion that the scaled POD and AOT40 values are underestimated.
- Lines 621: This has been suggested in other papers, consider citing Clifton et al. 2020, He et al., 2021, Baublitz et al., 2020.
- Section 3.1 – Consider starting this section by describing the question you aim to address here. It would be helpful to include a brief description of the simulations in the text (e.g. "Noah_D is the Noah model using the dynamic vegetation scheme").
- I found the ending to section 3.2.1 effective in drawing out the key takeaway of this analysis. I wonder if it be possible to pare down the key contributors to the DA influence on the model more (e.g. by describing the overall quantitative signal) than the somewhat broad list included here?

Technical corrections

- Line 36: "more important role in the Earth's climate system." Can you be more specific?
- Line 67-69: Clarify who expects the impacts of SM on v_d to be exacerbated or soften this claim. As written this sentence implies the IPCC makes this claim, which I don't

believe is true. The following sentence is clearer.

- Line 123 – does LIS/WRF-Chem have a version number?
- Line 124 – SMAP citation? Accessed date?
- Lines 132-133 – citations for IGBP MRIS, other dataset?
- Line 136: lass -> last
- Line 142: citation, access date for NLCD
- 252-256 – citations for these datasets?
- Line 331 – Please clarify what is meant by "The DA adjusted the modeled GVF and SLM fields toward similar directions"
- Sentence starting line 349: "Larger GPP and EF values…" the phrase "most of which" – please clarify if this relates to CLM_D or Noah_D?
- Line 383 – "skin temperature" is "surface temperature"?
- Sentence starting "These results can be mainly explained…" A nice sentence/finding.
- Figure 2 - difficult to read colorbar numbers, subplots e-h tough to see color gradient
- Figure 4 caption – says (g-j) but believe it should be (f-j). Can't see colorbar numbers
- Figure 8 – what is "non-urban"?
- Figure 9 – parts a) and b) look almost the same… consider simplifying to just v_d?
- Please break up the sentence starting on Line 634 for clarity, in particular of the last clause: "While the multiple no-DA…"
  - I think that "a common issue shared…" refers to the positive O_3 biases, but the way that it's written, it's not clear if referring to this or to the DA exacerbating the O_3
  - Please also include citations, eg: Li et al., 2018; Travis & Jacob, 2019; Val Martin et al., 2014