Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-175-RC1, 2018

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol and physical atmosphere model parameters are both important sources of uncertainty in aerosol ERF" *by* Leighton Regayre et al.

Anonymous Referee #2

Received and published: 4 March 2018

Review of "Aerosol and physical atmosphere model parameters are both important sources of uncertainty in aerosol" by Leighton Regayre et al.

This manuscript documents a suite of perturbed parameter experiments to try to understand the radiative effects of aerosols, both the direct radiative and indirect cloud effects. The paper builds an 'emulator' based on perturbed parameter experiments, and then uses it to understand the different sensitivities to aerosol and cloud parameters. The paper is topical for ACP, it is well written, and should be publishable with some substantial revisions and clarifications which I outline below.

Most fundamentally, I have some concerns about the quantitative aspects. The abstract

focuses on percentages of variance explained, but this seems to be entirely dependent on the choice of parameters.

In addition, the discussion of a few items needs to be better as noted below. First, the expert elicitation mentioned in passing in the conclusions is interesting, but needs its own section in the results first. As noted below, I'd be interested in a TOA constraint based on minimizing the root mean square spatial difference from observations, not just the mean TOA. In addition, I think perhaps TOA flux should be first section in the manuscript.

Finally I'm not sure how the authors go to regional, that might take a bit more discussion. Is it an entirely different emulator. I think it might be good to show an emulator figure to explain the method a bit more.

Detailed comments are below:

Page 1, L14: This does note seem like much of a change. Also: seems like a large value.

Page 1, L12: is this 60% of the 60% aerosol uncertainty for 4 parameters?

Page 1, L15: isn't the TOA flux 2 orders of magnitude larger than 2wm-2 ERF ($\sim$240 Wm-2)?

Page 6, L181: if the choice of parameters is arbitrary, then the fractions I think in the abstract are arbitrary. Please clarify: I assume some parameters were thrown out, are you sure you have a comprehensive set and another choice of parameters will give the same percentage change?

Page 12, L376: autoconversion is more important but overstated? This is confusing. Please rephrase.

Page 12, L383: is ERF the total? I.e. ari and ACI? Can you separate them?

Page 13, L406: there is an emulator for each gridbox for TOA flux? Maybe a figure is

necessary.

Page 18, L504: how much does this parameter affect TOA flux? Figure 4just shows the ERF. What would a plot of the actual TOA variance look like?

Page 24, L602: this concerns me since I think a different set of parameters will behave differently.

Page 25, L617: how were the regions identified? Sigma? Please clarify.

Page 30, L718: so you have used a total global value. But this can be a result of cancellation of errors. What if you tried to minimize the RMSE v. CERES? Would that give a similar result? Usually the RMSE is better for model evaluation v. Obs.

Page 31, L719:figure 12 is a bit confusing with the multiple axes for ERF over the different periods. Maybe divide it differently?

Page 31, L726: fig 13 is confusing. I take away that the only thing the observations do is constrain rad_mcica_sigma to a narrower range. The discussion is good, but maybe the figure could be simplified.

Page 35, L831: where did you analyze the expert elicitation selection? Did I miss something?

Page 36, L836: how much is that dependent on the parameter set choice?

Page 36, L840: might be good to mention what fraction are natural aerosol emissions or preindustrial background to compare to previous work. How do these results differ from Carslaw et al 2013?

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