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Geoscientific Model Development Discussions

Interactive comment on "First forcing estimates from the future CMIP6 scenarios of anthropogenic aerosol optical properties and an associated Twomey effect" *by* Stephanie Fiedler et al.

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This paper provides useful documentation of the MACv2-SP aerosols that some models without their own aerosols will use for their CMIP6 simulation.

It should be made very clear in the text that the ERFs from using these aerosols are smaller in magnitude by more than a factor of 2 than assumed by the IAMs when the scenarios were created therefore (all other factors being equal) future temperatures are likely to be less warm in these scenarios (except SSP3-ref) than expected by the IAMs, or compared to interactive aerosol models whose aerosol ERFs are closer to that of the IAMs.

Specific comments:

Page 1, line 2: It is stated that the scenarios are based on SO2 and NH3, but elsewhere biomass burning is mentioned with different single-scattering albedo.

Page 1, line 6: "Almost all scenarios": Could mention here which one doesn't show a decrease.

Page 1, lines 11-13: The different SSP scenarios do not reflect an uncertainty, but rather societal choices, i.e. it is not a random outcome, but up to us to choose whether we reduce aerosols or not (there are of course uncertainties between the IAMs within each societal choice, but these aren't considered in this paper). The ERFs for the different scenarios therefore shouldn't be referred to as a spread but rather listed individually: "-0.15 for SSP1-1.9, -0.54 for SSP3-ref". To make the abstract clearer I suggest to only list ERFs, as readers can easily find the RFs in the text if they want.

Page 1, lines 13-14: Similarly the uncertainties in physics shouldn't be mixed with choices in scenario. Rather list the effects on the two extreme scenarios: "uncertainty in Twomey effect could increase these to -0.39 and -0.92.".

Page 1: There should also be a statement of the aerosol forcings provided by the IAMs themselves (-0.365 for SSP1-1.9, -1.017 for SSP3-ref).

Page 2, line 18: There should be some comment here or later in the text about how reasonable the linear relation between tau and emissions is.

Section 2.2: This methodology wasn't easy to follow. If the sum in eqn (2) is simply over SO2 and NH3 this should be make more explicit. Does the statement that these source "contribute one third of the total global emissions in 2005" refer to total anthopogenic+natural? If it is anthropogenic only, where do the other two thirds come from? Is the SO2/NH3 weighting the same for open burning as industrial sources – and if so why?

Section 2.3: This methodology wasn't easy to follow. Some tables listing all the exper-

iments would help. It is not clear whether some of the multiples of three are identical ensembles or whether they have varying parameters (such as eta_N). How does this then lead to 180 annual estimates of ERF and thirty estimates of RF?

Page 5, line 14: LBG should be spelled out in full, along with a short description of the implication of lowering the background.

Section 3. This needs to be clearer about which experiments are run with the 9 scenarios in table 1 and which with the 3 scenarios in table 2.

Page 7, lines 31-4: The RCP scenarios used by studies cited here had very different aerosol emissions to the SSPs. Does it make sense to say your estimates are consistent?

Page 8, lines 8-9. It is not necessarily the variability in the rapid adjustments that causes the variability in the ERF, but rather that the methodology used is sensitive to the interannual variability in the clouds. For instance the ERF for no change in aerosols will still have a large interannual variability even though we know the rapid adjustment (and ERF) is exactly zero in every year (and indeed every timestep).

Page 8, line 12: “Efficacy” is often used for temperature response. Suggest to use “efficiency” here.

Page 8, lines 14-15: It is not obvious how the authors know the edge of the biomass burning plume is more strongly absorbing as the optical depth is only based on SO2 and NH3 emissions?

Page 8, lines 22-24: This apparent positive rapid adjustment needs further discussion. Known adjustment processes tend to be negative (e.g. Smith et al. 2018 https://doi.org/10.1029/2018GL079826). These apparent adjustments could be the effect of circulation changes on the clouds.

Page 9, lines 7: As with the abstract these numbers should not be referred to as a spread, but as ERFs for the SSP1-1.9 and SSP3-ref scenarios.

Page 9, lines 10-11: As before, it does not make sense to add in physical uncertainties to difference in scenario choice.

Figure 1: It would be better to keep the same scale for all these.

Figure 6: Use “Efficiency” rather than simply “E”.

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