

Interactive comment on “Anthropogenic aerosol forcing ndash; insights from multi-estimates from aerosol-climate models with reduced complexity” by Stephanie Fiedler et al.

Anonymous Referee #2

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The manuscript presents a 4-model ensemble assessment of simulation variability for anthropogenic aerosol radiative forcing simulations. The four models represent a reasonable (if small) cross-section of the global models available. My main comments are focused on improving the clarity of analysis and presentation.

The estimate of variability in ERF seems to be overestimated: it is based on differentiating the time-series of pre-industrial simulations from those with anthropogenic aerosols. Should not an average of the pre-industrial simulations be used for the differencing baseline to avoid this? This is relevant to the discussion of inter-model variability relative to natural variability as well. Further, since the differences are done for each

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of the three anthropogenically-influenced simulations, does it make sense to discuss correlations due to common variations driven by this approach?

I found it difficult to nail down exactly what was fixed between the different models in the simulations. Line 20 of page 2: “.. prescribing identical anth. aerosol optical properties across models allows us. . . if we . . . know the aerosol distribution” - suggests that optical properties and concentrations are prescribed. Line 9 of page 3 indicates that they “prescribe identical optical properties of anthropogenic aerosols and an associate effect on the cloud reflectivity”, which I assume to mean only the intrinsic optical properties. However on page 5 , line 24, it appears, again, that the optical depth is prescribed (“.. with pre-industrial aerosol optical depth. . . as of the year 1850, three experiments with with tau-p and anthropogenic aerosol from MACv2-SP for the year. . .”), an extensive prescription that appears to fix also the emissions/atmospheric loads of the aerosol. This is fundamental to the paper and should be made crystal clear to the reader, especially in light of the findings about intra-model variability. For example, at line 19 of page 2, the point is made that “uncertainties in process modeling of anthropogenic aerosol” can be separated, but if optical depth is prescribed, I don’t see how this is correct.

On numerous occasions, I was confused by wording and lack of specificity. I recommend that the authors perform a through line-by-line reading to make everything as clear as possible. Here are a few examples: 0) The term “multi-estimates” in the title does not appear to be widely used. Perhaps “multiple model estimates” might be more intuitive and familiar to the reader. 1) Abstract, line 4: “In those models we reduce. . .” - this makes it sound like a reference to only the models in the CMIP6. Better: “Here we reduce. . .” 2) Abstract, line 11 : “we reduce model diversity in clouds and use. . .” here “model diversity in clouds” is too vague - what is it referring to? 3) final sentence: what does “more stringent test” mean?

In Sec. 2.1, it is stated that anthropogenic aerosols are included in the pre-industrial burden, but don’t form the majority contributor of AOD in the NorESM. However, the

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reader needs more information about this to evaluate not the difference between anthropogenic and natural aerosols, but between pre-industrial and more contemporary simulations. One way to do this would be, for example, by providing the absolute anthropogenic contribution to global AOD in the two cases, to show if the pre-industrial case the anthropogenic contributions are small enough not to invalidate the results from this model relative to the others in the difference.

Last sentence of page 9: please provide some quantitative estimate of possible differences in natural emissions between pre-industrial and current day (for example due to land use changes etc.)

Line 17 of page 10: Clarity: it is not clear how consideration of variability does not affect an actual change in ERF. Perhaps the authors mean that they perceive the change as small relative to additional changes reflecting variability? This point is made more clearly in the conclusion.

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