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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Climatic effects of 1950–2050 changes in US anthropogenic aerosols – Part 2: Climate response" *by* E. M. Leibensperger et al.

Anonymous Referee #2

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Review of "Climatic effects of 1950-2050 changes in US anthropogenic aerosols - Part 2: Climate response" by Leibensperger *et al.*, submitted to *Atmos. Chem. Phys.*

The authors discuss the direct and indirect radiative effect of U.S. anthropogenic aerosols and the associated global and regional climate response. Main results include the regional nature of the response, and that most of that response has already happened. The topic and paper are interesting, and the manuscript is clear and well written. I suggest publication after minor revisions, mainly to address some concerns about the impact of the experimental setup on results.

1 Main comments

The authors use monthly-mean aerosol fields: this choice can impact the modelled aerosol forcing. They also use a q-flux ocean: this choice can impact the model response. Both impacts should be discussed in the paper along the following lines.

Using monthly aerosol fields instead of interactive fields modelled online causes two problems. First, the indirect effect is non-linear and monthly-mean aerosols will exert a different effect than interactive aerosols (see Appendix B of Jones *et al.*, 2001). The authors state (page 24137, line 6) that their "*indirect effect is comparable in magnitude to the direct effect*". This is surprising: I would expect the indirect effect to be stronger, especially for aerosols of the chemical compositions found in the United States. The experimental setup may underestimate the indirect effect. Second, the climate response to aerosol radiative effects will in turn affect aerosol distributions: different clouds will lead to different wet deposition rates, for example. This effect cannot be captured using the experimental setup used in the study.

From experience, a q-flux ocean responds more quickly and more sharply to a perturbation than a dynamic ocean model. When the authors state (page 24138, line 19) that "*some GCM studies find a strong spatial correlation between regional radiative forcing and climate response*", I strongly suspect that the way the ocean is represented matters. A q-flux ocean model will not let the response move away from the forcing, and the regional response will therefore be stronger.

2 Other comments

- Page 24136, line 8: A radiative forcing of +0.4 Wm^{-2} is not that weak. How strong must a forcing be to exert a response that can be distinguished from the model internal variability?

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- Page 24138, line 7 and page 24145, line 5: A reason why the model underestimates surface radiation trends can simply be that the model underestimates aerosol radiative effects. Having reasonable aerosol fields does not guarantee radiative effects are correct, unfortunately.

- Page 24145, line 14: SST anomalies and aerosol radiative effects can very well be linked together.

3 References

Jones, A., D.L. Roberts, M.J. Woodage, and C.E. Johnson. Indirect sulphate aerosol forcing in a climate model with an interactive sulphur cycle. *J. Geophys. Res.*, **106**, D17, 20293-20310, 2001.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 24127, 2011.