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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impacts of emission reductions on aerosol radiative effects" *by* J.-P. Pietikäinen et al.

Anonymous Referee #2

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Pietikäinen et al. estimate changes in the aerosol radiative effect (direct+indirect) due to projected reductions in emission of SO2, black carbon, and organic carbon, following four future scenarios. The authors discuss regional to global changes in atmospheric burden and radiation. The scenarios include current legislated and maximum feasible emission reductions.

While the results of this work are of great interest to the community, more detail is needed in some sections (as discussed below). The manuscript is generally well-written, but an edit by a native English speaker is recommended. This paper is within the scope of ACP and I believe it will meet its standards once the following comments are addressed.

General Comments

- The magnitude of emission changes in the four future scenarios is not specified, globally or regionally. A table of regional emission changes for each scenario would be useful for future comparisons and better understanding of changes in burden/radiative effect. In addition, it is not clear what emissions are being modified. Are CO, VOCs, NOx, methane, etc. also being modified?

- The choice of 2005 as a reference year is an improvement over many studies that default to 2000. However, there have been significant emission-driven changes in aerosol distributions between 2005 and 2015. I recommend a couple sentences discussing the impacts of 2005 vs. 2015 as a reference year. Similarly, discussing changes between 2005 and 2020 as "future" changes is interesting since we're already 2/3 of the way to 2020.

Also, it would be interesting to know how close (or far) the 2005 to 2030 reductions are from pre-industrial levels. For example, are we at 50

-Comparing simulated burdens to Schulz et al. (2006) is great, but AeroCom simulated year 2000 conditions, which should differ from 2005. This should be mentioned. More recent multi-model intercomparisons include AeroCom II (Myhre et al., 2013) and AC-CMIP (Shindell et al., 2013). These intercomparisons also commonly default to 2000 as a "reference", but represent the most up to date multi-model estimates.

- The calculation of the aerosol radiative effect needs a more thorough explanation. Nudging the model to ERA-Interim is fine, but then an effective radiative effect may not be particularly meaningful. However, it is unclear if the authors are estimating true radiative effect (parallel calls to radiation schemes) or the effective radiative effect (difference in TOA radiation between paired simulations). I believe it is the latter.

Terminology needs to be clearer as well. The direct radiative effect is presented in Fig. 5. This is different from radiative forcing and should be defined in the methods section, ideally when the forcing (or radiative effect) calculation algorithm is spelled out.

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- Changes in burden and DRE are compared to previous studies throughout this paper and it is rightly pointed out that comparisons are complicated by differing models, emissions, future scenarios, etc. But I think an important comparison would be to the more commonly used RCP scenarios, i.e., Shindell et al. (2013), which make different assumptions.

The authors may also be interested in comparing to a similar study by Kloster et al. (2008) using the same model.

- The manuscript could be greatly improved with a more thorough discussion of the implications of the various scenarios for climate and air quality. Such an analysis, or a comparison of the four scenarios to the RCP scenarios (previous point), would strengthen the current paper.

Specific Comments

- The sign convention in the abstract and throughout the text is difficult to follow since aerosol RF is negative. Perhaps saying the magnitude decreases will provide clarity.

- In the abstract I am left wondering what the 2005 vs. pre-industrial RF is, i.e., what percentage of the overall magnitude is a 0.06-0.4 W/m2 decrease?

- The penultimate sentence of the abstract is a bit puzzling. Does this include air quality considerations or just climate effects?

Page 31901, line 3-6: But some models have been unable to simulate the magnitude of dimming with only aerosols [Wild et al., 2009; Koch et al., ; Leibensperger et al., 2012].

Page 31901, line 9: “Loosing” should be “losing”

Page 31902, line 10: “How these” should be “How do these”

Page 31902, line 12: “To what extent these patterns can be influenced by . . .” should be “To what extent are these patterns influenced by . . .”

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Page 31904: Is the difference, in terms of aerosols, between CLEC2020 and CLECC2020 the additional reductions in aerosols occurring because of decreases in co-emitted precursors? A sentence should be added here to clarify since only CO2 is currently referenced.

Page 31910, lines 6: Redundant word “models models” and “resorting to” should likely be replaced with “using”.

Page 31916, line 14: Also see IPCC AR5 for more recent DRE estimates.

Page 31917, last paragraph: This is a very interesting paragraph, but I am having difficulty following the logic. I suggest a bit of editing.

Figure captions: Acronyms (e.g., SA) should be spelled out

References

Kloster, S. et al. (2008) Influence of future air pollution mitigation strategies on total aerosol radiative forcing, Atmos. Chem. Phys., 8, 6405-6437, doi:10.5194/acp-8-6405-2008.

Koch, D. et al. (2011) Coupled aerosol-chemistry-climate twentieth-century transient model investigation: Trends in short-lived species and climate response, J. Climate, doi:10.1175/2011JCLI3582.1.

Leibensperger, E.M. et al. (2012) Climatic effects of 1950-2050 changes in US anthropogenic aerosols – Part 2: Climate response, ACP, doi:10.5194/acp-12-3349-2012.

Myhre, G. et al. (2013) Radiative forcing of the direct aerosol effect from AeroCom Phase II simulations, Atmos. Chem. Phys., 13, 1853-1877, doi:10.5194/acp-13-1853-2013.

Shindell, D. et al. (2013) Radiative forcing in the ACCMIP historical and future climate simulations, Atmos. Chem. Phys., 13, 2939-2974, doi:10.5194/acp-13-2939-2013.

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dimming/brightening and twentieth-century daytime and nighttime warming? JGR, doi:10.1029/2008JD011372.

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