Atmospheric
Chemistry
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Discussions

Interactive comment on "Anthropogenic aerosol forcing under the Shared Socioeconomic Pathways" *by* Marianne T. Lund et al.

Anonymous Referee #1

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In this paper, Lund et al estimate the future loading and radiative forcing of anthropogenic aerosols under three of the SSP emission scenarios. This is a good study in my opinion that merits publication in ACP following minor revisions as described in my detailed line-by-line comments below.

L18-19: The differences between 2100 and 2015 reported here should equal the 1750-2100 values (given in L14-15) minus the 1750-2015 value (-0.61 W/m2) I'd expect, but they don't. Seems like a mistake and accidentally the opposite of the 1750-2100 values are given here instead of the differences for 2100 vs 2015 which I'd think are +0.57 and +0.10 W/m2, respectively (unless the values in L14-15 are wrong). Or if there is some non-linearity or incompatibility between the various estimates please revise so this is not so confusing to the reader.

L43-44: Rather than the Li et al study cited here for air quality/health, which looked only at one country using one model, one of the worldwide multi-model studies by Silva et al would be a better choice (e.g. Silva et al, The effect of future ambient air pollution on human premature mortality to 2100 using output from the ACCMIP model ensemble, Atmos. Chem. Phys., 16, 9847-9862, 2016.)

Similarly, rather than (or in addition if you like) the Szopa et al and Westervelt et al studies, each of which looked at just one model, the reader could more usefully be pointed to the multi-model studies such as Shindell et al., Radiative forcing in the ACCMIP historical and future climate simulations, Atmos. Chem. Phys., 13, 2939–2974, 2013; and Rotstayn et al, Why does aerosol forcing control historical global-mean surface temperature change in CMIP5 models?, J. Climate, 28, 6608-6625, 2015.

L56: Clearer to write as "continue to be high and are increasing" than "also continue to be high and increasing" as the 'also' seems not to relate to the previous sentence (about SO2) but an earlier one so is hard to follow.

L56-58: It would be good to include additional explanation here that the RCP aerosol emissions were based on the assumption that economic growth leads to decreasing emissions of precursors, a so-called environmental Kuznets' curve/behavior. An excellent discussion of the background to assumptions such as those is given in Amann et al, 2013. Regional and global emissions of air pollutants: recent trends and future scenarios. Annual Review of Environment and Resources, 38, pp.31-55; and a recent paper analysed the link between economic growth and aerosol precursor emissions and indeed supports the discussion here (and in Amann et al) that RCP projections are likely too optimistic as those emissions do not necessarily decline with growth in GDP or follow CO2 (see Ru et al, The long-term relationship between emissions and economic growth for SO2, CO2 and BC, Env. Res. Lett., 13, 124021, 2018.) This discussion would help set the context for the new approach in the SSPs where air pollution controls have independent settings, as described in the next paragraph.

L74: Replace 'there is progress is slowed' with just 'progress is slowed'.

L90: Please also give the number of vertical layers and the model top as that'd help the reader get a general sense of the model in addition to the horizontal resolution.

L150: 'Becomes' -> 'become'.

L186: Delete 'the' before 'South Asia'.

L189: Add 'the' before 'Sahara'.

L201: Add 'that' after 'demonstrated'.

L220-221: The authors describe the conclusion drawn in the Stjern et al study about the semi-direct impact of BC here. They should also include the results of Allen et al., Observationally constrained aerosol–cloud semi-direct effects, npjCAS, 2, 16, 2019 as those suggest the semi-direct effect may not be well captured by the models used in Stjern et al and so drawing conclusions about the sign of the adjustment is less certain than the current text implies.

The same goes for text in L281-282 – might reduce temperature response not the more definitive 'have been shown to'.

L225-230: It would be helpful to be clear about the time periods for the forcing values quoted from these other two studies (for Fiedler, forcing when vs when; for Partanen, it is stated that it's for 2100, but relative to when?).

L269-282: The discussion here starts to delve into the role of individual aerosol species, which is good. I like the current discussion regarding SO2 and BC. I'd like to see a bit more on this, however, in particular I would request that the authors extend their Table S1 to include the year 2100 (data they should already have), and add a discussion of the nitrate forcing towards the end of the century given the large increase in burden shown in Figure 1h for SSP3. That could be usefully compared with the results of the Bauer et al, Bellouin et al, and Shindell et al (see reference in comments on L43-

44 for the latter, the other two are already cited) studies that discussed the possibility of substantial increases in negative RF from nitrate over the 21st century.

L318-320: Again could compare with the Silva et al results for future RCPs (see reference in comments on L43-44).

L331: 'Impose' seems an odd word to use here, as usually things people don't want are imposed upon them whereas improved air quality is something people do want. I suggest changing to 'lead to' or something similar.

L332-347: The Methods section describes how only cloud albedo effects are analysed here (as RFaci is calculated offline). This section should point out that the calculations here not only neglect climate feedbacks, but neglect the entire cloud lifetime portion of RFaci, which may be important.

L363: Useful for those not so familiar with the SSPs to add "(SSP3)" after "regionally fragmented world with slower mitigation progress" here.

L365: "Increases" -> "increase" and "starts" -> "start".