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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Distributions and climate effects of atmospheric aerosols from the preindustrial era to 2100 along Representative Concentration Pathways (RCPs) simulated using a global aerosol model SPRINTARS" *by* T. Takemura

Anonymous Referee #1

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General comments

The paper describes a model study of evolution of the global aerosol and its climatic effects. The simulations cover time time zone from pre-industrial era to the year 2100. This kind of studies are important to quantify the future role of the the aerosols in the climate change. The study is mostly easy to read and well structured. The main shortcoming is absence of references to other studies modeling future aerosol scenar-

ios. I recommend the study to be published after the following comments have been adequately addressed.

Specific comments

1. Page: 20521 Lines: 7-9 “A decrease in the cloud droplet size due to an increase in CCN results in an extension of cloud lifetime and then to an inhibition of precipitation (e.g. Albrecht, 1989).” The aerosol second indirect effect for warm clouds is introduced as straightforward concept while the effect of ice nuclei is reported to have both positive and negative effect on mixed phase clouds. Lebsock et al. (2008) show that increasing aerosol concentration may lead to a decrease in LWP in warm non-precipitating clouds. The sentence should be modified to reflect that uncertainty.

2. The introduction cites several model studies on transient historical simulations, but none of the studies simulating future aerosol effects are mentioned. For example, Leibensberger et al. (2012) simulated effects of US anthropogenic sources for period 1950-2050 and Horowitz (2006) simulated aerosol concentrations from 1860 to 2100. Also the results section would be greatly improved is some comparison between this study and previous studies on future aerosol scenarios was provided. Please, include some references to other works that have simulated future aerosols and their radiative effects, compare your results to previous studies and discuss possible reasons for differences.

3. How do the model’s simulation of clouds and aerosol indirect effect compare with observations or other model simulations? This is discussed briefly in the results section, but some kind of summary in the model description part would be good. Are there large differences caused by treating only aerosol mass instead mass and number concentrations?

4. Author could add an explicit description /summary of the simulations made. Was the simulation with pre-industrial emissions run for years 1860-2100 also?

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5. Is adjusted forcing for a single simulation calculated by a double call of the radiation code with and without aerosols? If that is the case, then it should not be labeled adjusted forcing for a single simulation, because tropospheric state is not allowed to adjust. I understand that the term should be used for the difference between two simulations as the tropospheric state is different in eg., pre-industrial and RCP-simulations. In the text, "adjusted forcing" is used interchangeably with "Δ adjusted forcing" which is a bit confusing. See for example, Figure 8 and page 20530 lines 7-8. The author should clarify how adjusted forcing from aerosol direct effect is defined and use the term consistently.

6. Is "adjusted forcing" calculated for all-sky radiation values?

7. How is adjusted forcing from indirect effects calculated? This should be explained somewhere in the text.

8. Page 20529: lines 2-7 Can't there be some contribution of changes in the natural emissions to the AF even though sea surface temperature and sea ice extent are fixed? Are the wind speeds fixed also or are the changes in natural emissions negligible when sea surface temperature and ice cover are fixed?

9. Page 20532: lines 7-8 Being able to divide aerosol direct effects into contributions from different substances is a feature with bulk aerosol model. In internally and externally mixed aerosol population (in the real atmosphere) it would be impossible to make that kind of neat distinction. I think, that this should be briefly mentioned.

10. Page 20533-20534 AF from indirect aerosol effects is sometimes called just AF. It would be clearer if the distinction between direct and indirect effects is made every time term AF is used. For example lines 28-89 on page 20533-20534 say: "The year-to-year variations are, however, much larger than the variations due to the direct effect because the AF includes rapid responses from all aerosol effects, which affects the hydrological cycle."

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Technical corrections

11. Page 20536: line 4: A typo: “greenh ouse gases”

12. Table 1 and Table 2 are missing units.

References

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