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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Response of shortwave cloud radiative effect to greenhouse gases and aerosols and its impact on daily maximum temperature" *by* Tao Tang et al.

Anonymous Referee #1

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This paper investigates the response of shortwave cloud radiative effect and daily maximum temperature to greenhouse gases and aerosols (BC and sulfate). It is found that BC results in a stronger positive SWCRE change than CO2 when normalized by effective radiative forcing, but sulfate does not have much effect on SWCRE. It is also shown that the increase in SWCRE resulting from CO2 and BC leads to an increase in daily maximum temperature during the summer. The results are interesting and have some important implications, however a number of things need to be addressed before recommendation for publication.

Major:

1. Most of the results are normalized by effective radiative forcing. What are the surface temperature responses to CO2 and BC, respectively? Could the difference in SWCRE be partly due to the difference in the temperature change (i.e., the efficacy of BC)?

2. The SWCRE change is attributed to the change in cloud cover. I would be interested to see some discussion in the change in cloud liquid water content or liquid water path, which also plays an important role in determining SWCRE.

3. The change in cloud cover is explained by the change in RH. However, there are a lot of other factors affecting clouds (radiation, dynamics, thermodynamics, etc., see Bretherton (2015) and references therein), and I think a more detailed discussion would be helpful. The authors look at vertical velocity and suggest that the change in stability plays less of a role, but it is not clear to me how the conclusion is reached. The estimated inversion strength or lower troposphere stability may be a better predictor for stability.

4. I have some conservation about including downward LW in the multilinear regression model. It is possible that downward LW change is a result rather than a cause of Tmax change (Tmax change results in changes in boundary layer temperature and moisture, and thus downward LW). In fact, consider the approximation LW$\sim\sigma$T^4, dLW$\sim$4σT^3dT, with T$\sim$300 K, dT/dLW$\sim$1/(4σT^3)$\sim$0.16, which is very close to the coefficients derived from the regression.

5. In PDRMIP BC and sulfate are increased by a factor of 10 and 5, respectively. It may be helpful to comment on whether the response is linear for such a large change. The small SWCRE response to sulfate is interesting and somewhat surprising. Given that aerosol direct effect is probably more linear than aerosol indirect effect, would the authors expect different SWCRE response to historical change in sulfate?

Minor:

1. Please clarify that the paper analyzes SWCRE at the surface in the abstract, the

main text, and the figures. It is somewhat confusing because I think SWCRE is more commonly referred to as TOA radiative forcing, and the first paragraph in the introduction describes SWCRE at the TOA.

2. Eq.(1): What is the time frequency of q and V for calculating the moisture flux?

3. Figure 7: Maybe show the fast and slow responses of SWCRE instead of cloud cover, as the paper focuses on SWCRE.

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