Review of the manuscript "Changes in clouds and thermodynamics under solar geoengineering and implications for required solar reduction" submitted by R. D. Russotto and T. P. Ackerman for publication in ACP

In the G1 simulation of GeoMIP it is attempted to reach TOA radiative balance under instantaneous quadrupling of CO2 by a decrease of solar irradiance. It had been recognized earlier that the solar constant has to be reduced more than estimated using simple assumptions, i.e. a change of solar irradiance seems less effective than the changing CO2, but to my knowledge, the reasons for this behavior had not been comprehensively analyzed. This paper closes this gap in a, in my opinion, very convincing way, at least to the extent this is possible with the available model output. The authors have used direct analysis of model output and the technique of radiative kernels to infer that the LW adjustment due to changes in atmospheric (in particular stratospheric) temperatures and the SW adjustment related to decreasing low cloud cover in G1 are the largest contributors to the underestimation of the necessary solar constant reduction. I think these results are very useful for the discussion of solar geoengineering methods but also for understanding responses to solar and GHG forcing. I find the paper in general very well written, and the selection and quality of tables and figures very appropriate. In summary I recommend publication of this paper after consideration of the following minor issues:

- P5L20: "ant"
- In several places, the overall cooling in the free troposphere is mentioned, which is explained with the surface cooling and the temperature profile following a moist adiabat (page 6). However, the globally averaged surface temperature does not increase in G1. It would be useful to mention why the tropical cooling dominates the temperature change in the free troposphere.
- P9L18: It is argued that a reduction in low clouds would partially counteract the cooling from solar geoengineering. However, the authors do are not able to discriminate if CO2 or solar irradiance changes lead to the adjustments. Hence, I don't understand why this change in clouds is related to the irradiance change.
- Table 3: It might be useful to add a line with the multi-model mean (which is even referred to in the text) to this table, and possibly also Table 2.
- At some places (e.g. P22L8) the authors talk about something "predicted" by Eq. 8. I think it would be useful to mention already early (it is done only in the Conclusions) that this is a prediction in hindsight, based on the analysis of the model results, or even avoid the word "prediction".
- Last paragraph of Section 4. I'm wondering if this shouldn't go to Section 3.
- P25L17: I find the remark on a "smaller-scale geoengineering test" not specific enough. What means smaller? I think also the reference is unfortunate, because Keith et al. (2014) only cite another paper (McMynowski et al., 2011) for providing an estimate of what small could mean and I have the impression they cite them wrongly. So I'd suggest to rather cite the original publication and be a bit more specific.
- P25L21: "If solar geoengineering was attempting to cool the planet instead of simply preventing future warming … then temperature dependent feedbacks …" I don't understand this statement. It all depends on the reference. If it is preindustrial climate then also a stabilization would include temperature feedbacks. And in the case of a cooling these would depend on the amount of cooling.