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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Changes in clouds and thermodynamics under solar geoengineering and implications for required solar reduction" *by* Rick D. Russotto and Thomas P. Ackerman

Anonymous Referee #3

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General comments:

The manuscript analyses results from experiment G1 under the model intercomparison on geoengineering (GeoMIP). Here, the solar constant is reduced so as to keep the top of the atmosphere radiative balance at zero when abruptly quadrupling the atmospheric CO2 concentration. The article discusses why the reduction in solar constant must be larger than what is predicted based on instantaneous and long-term effects of the CO2 increase alone and that rapid adjustments to the change in solar radiation must be taken into account. The manuscript is very well written and easy to follow, the authors present good graphics and tables to support their discussion and they use suited sci-

entific methods in form of radiative kernals to decompose their radiative responses into rapid adjustments of different parts of the climate system. My only major objection is how the discussion is angled towards the potential use of their Equation 3, which to me is just a description of the radiative processes involved. The terms of this equation cannot be known before the experiment is run and it is therefore a bit misleading to suggest that it could be used to find a suited change in solar constant to counteract some positive forcing on the climate system. The equation does, however, support the results from the radiative kernals and should rather be used as a tool to test the validity of these results.

Specific comments

- P1, L21: "High cloud fraction increases.." Intuitively, this should also give a warming effect. You show later that this effect is not. I suggest to mention this here or to rewrite a bit. I was a bit puzzled why the increases in high clouds were not part of the following sentence on warming effects.

- P3, eq (2): Though obvious to most, perhaps you should state where this number comes from?

- P5, L8. "Existing tools. . ." A bit vague. Mention kernals already here.

- P5, L10: ". . .and not "feedbacks". . .". This is true on a global scale, but is it true on a regional scale? You state that the surface temperature increase in the polar regions and Figure 7c shows a clear effect on solar radiation from surface albedo changes.

- P5, L20: ". . .ant . . ."

- P9, L18: "An increase in high cloud fraction would. . ." This is true and in this experiments, the temperature at these altitudes have decreased, which should enhance the effect further?

- P9, L22: ". . .due to a reduction in LW emission from the cloud top" I am confused – how does something get warmer from receiving less radiation? Please clarify this

sentence. Reduced high cloud cover will expose the region above to more surface radiation as this is now allowed to reach higher altitudes.

- P16, table 3: Can you not just put a minus sign in front of the solar forcing to avoid the +/- confusion?

- P19,L1: *. . .LW effect of the decrease in low cloud cover fraction compensates for this." Is the temperature difference between the cloud top and the surface large enough to explain this? Or are you discussing surface warming here? Please clarify.

- Conclusions: I find the conclusion of the manuscript a bit wordy and I suggest trimming this section and making more about the results in this study rather than a speculation into future possible geoengineering challenges.

- P23, L17: Typo "This paper we explains.."

- P25, L12: The PDRMIP experiments actually contains multimodel runs of both reduced solar constant and increased CO2 and could therefor provide the data you need to look further into this.

- P25, L21: "If solar geoengineering was attempting to actually cool the planet. . ." What? Back to preindustrial conditions?

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