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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Climate extremes in multi-model simulations of stratospheric aerosol and marine cloud brightening climate engineering" *by* V. N. Aswathy et al.

Anonymous Referee #3

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General Comment #0:

I am going to abbreviate Climate Engineering by Stratospheric Aerosols as "SACE" just so I can contrast it with SSCE.

General comment #1: I think the way these simulations are usually analyzed can lead to misleading conclusions and I would like these authors to help to straighten out this problem. Alterskjær et al (2013) indicate that the "The (G3) SSCE experiment is designed so as to cancel the globally averaged radiative forcing relative to 2020 associated with the RCP4.5 scenario [Moss et al., 2010]". Berdahl et al say "G3 injects

sulfate aerosols beginning in 2020 to balance the anthropogenic forcing and attempt to keep the net forcing constant (at 2020 levels) at the top of the atmosphere [Kravitz et al., 2011a]".

This study says (page 32396/L7-8) that G3 is designed "to balance the anthropogenic forcing and to keep the global temperature nearly constant (Kravitz et al., 2011).", and then says (page 32396/l10) that for G3-SSCE that "marine cloud brightness is altered, rather than stratospheric aerosols, are used to compensate the anthropogenic forcing." In all of these studies there is a comparison of the 2010-2019 decade with a later decade (2060-2069 or 2080-2089), with the implication that the scenarios were designed to maintain either temperature or precipitation at 2010 levels. Because of the climate forcing is not zero at 2010 or 2020, and there is a "climate commitment" (e.g. the planet will continue to warm even if forcing were to be fixed at those levels and forcing is not fixed) it is by no means clear that the CE would satisfy these assumptions. For the G3 scenarios, the appropriate forcing must be guessed ahead of time, and so one should anticipate that the planet will continue to warm after 2020 for both geoengineering scenarios, and as seen for example in figure 1 of Berdahl et al (2014), and in table 1 and figure 1 of Alterskjaer, the forcing is not fixed in time, does not balance the greenhouse gas forcing, and the climate continues to change over the integration period. Therefor the G3 behavior should be distinguished from the G1 simulation, where there was a strict requirement that the TOA net flux be balanced for an extended period to 0.1 W/m2.

Because of this, one should not expect that there will be a reasonably complete compensation between the albedo modification and GHG forcing, and the study should reduce expectations about how strongly it should be achieved (e.g. on page 32394/l17 you say "are not completely alleviating the changes"). If the statistics do not stay constant it is as much an artifact of the experimental design as it is the choice of CE method.

General Comment #2: I am getting tired of reading geoengineering papers that deliver the same messages over and over again. It is not that I don't believe the messages, I just don't think much detail is required when they are a repeat of previous studies. So I would encourage the authors to reiterate common conclusions with previous studies very briefly and very clearly, and then focus on aspects of these simulations where something new is to be learned from the simulations. I feel that the authors provide so much detail that one cannot see the forest for the trees. Here is my summary of the study:

Things that are the same as previous studies:

1. The planet cools with either geoengineering method (SSCE or SACE), and precipitation decreases.
2. Warm/Moist precipitation events are mitigated by either CE method. Cold/Dry events are not.
3. The compensation is more effective in the tropics than in polar regions
4. There is a slight increase in width of the PDF of extremes events (as described in Curry et al) with geoengineering compared to the reference state, but, like Curry et al the resulting PDF is found to be much much closer to the "2010s world" than the RCP scenario with no geoengineering.
5. The signatures of weaker cooling over land with SSCE than SACE are the same as those found in the idealized studies by Bala and Caldeira (which I think should be cited)
6. The planet warms, and precipitation increases following termination. I feel like saying "duh", but if there is something new learned in this study I would be delighted to learn it.

I think these points should appear and be stated much more succinctly. Things that seem new or I have questions about:

1. How different is the TOA forcing between G3-SSCE and G3? In the shortwave and in the longwave? Over land and over ocean?
2. Temperature statistics (differences with the 2010s world) seem relatively insensitive to whether one uses SACE or SSCE
3. I would like the authors to discuss how different the extreme events are from those predicted by the idealized studies (i.e. G1). Is G1 an adequate design strategy for understanding extreme events.
4. It seems from table 2 that the precipitation over land is better treated by SACE than SSCE, but precip over ocean is better treated by SSCE.
5. Are the differences between the two CE methods large enough that you feel they are robust and not artifacts of the scenario details?

I quite liked the summary.

Page 32398/l20: "The G3 and experiment". There is a word missing after "and".

Page 32417: "Realtive" should be "relative".

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 32393, 2014.