Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2017-434-RC1, 2017
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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impacts of Stratospheric Sulfate Geoengineering on Tropospheric Ozone" *by* Lili Xia et al.

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Received and published: 6 June 2017

Review on:
Impacts of Stratospheric Sulfate Geoengineering on Tropospheric Ozone (acp-2017-434)
Lili Xia et al

June 6, 2017

Xia et al describe the impact of two solar radiation management (SRM) techniques, stratospheric sulfur injections and solar dimming, on tropospheric and stratospheric ozone concentrations. They use a Earth-System model coupled to a chemistry and a

land model. With this model setup they are able to simulate not only the impact of SRM on ozone but also the relation to plants.

Only few geoengineering studies put the focus on ozone changes. Changes in ozone are an important side effect of SRM. Therefore, this paper helps in further understanding possible consequences and side effects of SRM. The paper is well written and I support publication after addressing the following minor remarks.

General:

Different to the GeoMIP experiments G1 and G3, where greenhouse gas forcing is counteracted by balancing the top of the atmosphere (TOA) imbalance, the two techniques in this paper are balanced by the solar TOA forcing. However, they compare the results to Ferraro et al (2014) and Niemeier et al (2013) but these studies used the TOA imbalance. The paper is missing a discussion of this aspect. It might be an option to apply a bias correction, following Niemeier et al (2013). At least the discussion on precipitation should include the TOA energy balance and follow Liepert and Prevedi (2009) (see also Eq 8 in Niemeier et al 2013).

The naming of the experiments is sometimes confusing for the reader. Both SRM techniques start with S. G4SSA and G4SOL could be an alternative.

Specific comments:

Line 119: The number of vertical levels is quits small compared to the horizontal resolution.

Line 128: Can you discuss the possible impact of the reduces solar radiation on the photolysis rate.

Line 169: This sentence is miss leading. It sounds like all references warm by 3 K.

Line 170: G4SSA-S shows also a slight warming in the lower stratosphere. Why?

Line 178 to 183: TOA imbalance as mentioned above. The difference between R-toa and R-surf are compensate by condensational heating.
Eq 1 in Niemeier et al (2013) was used for a bias correction. It might be an option to use this correction (G4SSA-S for I-FIX) to compensate the solar balancing but G4 has still a transient climate. However, it might be worth trying.

Line 187: 'They attribute...' better 'Ferraro attribute ..' This was described earlier in a paper by Bala et al (2008).

Line 222: Adding a row with differences in percent to the plot (Fig 7).

Line 324: You say earlier that you do not change the photolysis rate. How is the the reduced sunlight changing ozone here?

Line 356: This is not the only way to exchange ozone between stratosphere and troposphere. STE due to tropopause folds in the surf zone might be more important.

Line 383: Have you mentioned black carbon before?

Line 373 to 385: Your study uses a fixed QBO, different to Aquilla et al (2012). This may play an important role. Niemeier and Schmidt (2017) show also an increase in vertical velocity as well as a strong impact on stratospheric transport. This aspect cannot be taken into account in this study but might be discussed as a caveat.

Figures

May explanations in the text base on figures in the appendix. You may add them, or some of them, in the main text. It is easier for the reader and does not really matter in an online paper.

Fig 2: Plot the ensemble mean as a running mean. This helps in recognizing differences or similarities.

Fig 4 and fig 8: It would be nice to see the position of the sulfate aerosol as a contour line.

Fig 5: Add TOA energy fluxes

Fig 6: Add additional years to the x-axis. Ozone decreases in RCP6 from roughly 2050, in G3SSA-S as well but not in G4SSA. Do you have an explanation?

Fig 7: Add a row with differences in % (or use the figure from the appendix).

References

Bala et al (2008): doi:10.1073/pnas.0711648105

Liepert and Prevedi (2009), J.Climate, http://dx.doi.org/10.1175/2008JCLI2472.1

Niemeier and Schmidt (2017): ACPD, https://doi.org/10.5194/acp-2017-470

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-434, 2017.