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# Comment on acp-2021-569

Sandip Dhomse (Referee)

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Referee comment on "An interactive stratospheric aerosol model intercomparison of solar geoengineering by stratospheric injection of $SO_2$ or accumulation-mode sulfuric acid aerosols" by Debra K. Weisenstein et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-569-RC1, 2021

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Review for Weisenstein et al.,

"A model intercomparison of stratospheric solar geoengineering by accumulation mode sulphate aerosol"

Submitted ACPD

Here authors analyse CCM output from a dedicated *GOIP* solar engineering experiment "AM-H2SO4". This experiments is designed to inject geoengineering Sulphur (S) in the stratosphere in terms of particles (SO3 or H2SO4), so that stratospheric aerosol particles would grow mainly in accumulation mode, thereby negating effects of faster particle growth (and associated particle sedimentation). Analysis in this manuscript suggest that only three CCMs (WACCM, ECHAM5-HAM and SOCOL-AER) managed to complete these simulations. Basic idea behind these simulations is to differentiate model response to the SO2 vs particle injection under different (5 vs 25) Tg S injection magnitude scenarios. Authors find that all three models show increased radiative efficacy (in terms of radiative forcing) when Sulphur is injected in "AM-H2SO4" mode compared to gas phase injection. Also sensitivity simulations with different injection patterns (two points at 30° N and 30° S vs injection in a belt along the equator between 30° S and 30° N) find opposite response.

Overall this is well written manuscripts and fits well within ACP scope. Hence, I will like to recommend this manuscript for the publication with minor corrections.

Minor Comments:

- Page 3: Line 28: Does that mean ECHAM has identical ozone loss in all the simulations?
- Line 6 Line 18: I am really surprised that you use only 2 year spin up period. If you plot plot global burden, you would see steady increase in burden before curve flattens, depending on dry and wet deposition schemes. Unless you have meteoric smoke particles transporting or mopping S-containing species downwards and there is lack of particle evaporation (temperature increase due to ozone increase), gas phase tracers (e.g. SO2, H2SO4) would show steady transport upwards Overall tracers should reach to equilibrium state near model top after 3 to 4 years as they transport downward in the polar vortex. I think that is why WACCM (page 10 line 8) shows increasing residence with increase in injection amount. For e.g. Dhomse et al., 2013 (Figure 3) equilibrium for meteoric smoke particles is about 10 years. I suspect it should be at least 5 years for these simulations.
- Page 6: Line 19: What is baseline or reference simulation? Do you mean from respective SSP8.5 simulation? Is it from a single ensemble member or from ensemble mean?
- Page 8 : line 1: Are you sure about only 10%? One need to have very fast wet deposition. I think you should provide a line plot showing time variation in global burden.
- Page 9 : line 1: it should be other way round : weaker stratosphere troposphere exchange in the SH hence more aerosol accumulate in SH mid-lats.
- Page 11 : Figure 4: Does slope remain constant if you use only last 5 year data (5 year spin up).
- Page 12: line 9 : Any idea why ECHAM shows much weaker sensitivity.
- Page 18 : line 6 : Edit : $30^{o}$S-$30^{o}$N
- Page 21: line 19: Are you sure it is minor. In Dhomse et al (2015), it is about 3%. With significant Cly decrease, future ozone losses would be largely controlled by NOy chemistry (e.g. Ravishankara et al.,2009), I would expect up to 5% ozone increase in the tropical middle stratosphere.

Referenes:

Dhomse, S.S., Saunders, R.W., Tian, W., Chipperfield, M.P. and Plane, J.M.C., 2013. Plutoniumâ□□238 observations as a test of modeled transport and surface deposition of meteoric smoke particles. *Geophysical Research Letters*, *40*(16), pp.4454-4458.

Dhomse, S. S., M. P. Chipperfield, W. Feng, R. Hossaini, G. W. Mann, and M. L. Santee (2015), Revisiting the hemispheric asymmetry in midlatitude ozone changes following the Mount Pinatubo eruption: A 3-D model study, Geophys. Res. Lett., 42, 3038–3047, doi:10.1002/ 2015GL063052.

Ravishankara, A.R., Daniel, J.S. and Portmann, R.W., 2009. Nitrous oxide (N2O): the dominant ozone-depleting substance emitted in the 21st century. *science*, *326*(5949), pp.123-125.