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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Ozone changes under solar geoengineering: implications for UV exposure and air quality" *by* P. J. Nowack et al.

**Anonymous Referee #2**

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Review of "Ozone changes under solar geoengineering: implications for UV exposure and air quality", by Nowack et al. Submitted to Atmos Chem Phys

This global modeling study investigates the mechanisms and processes where solar radiation management (SRM) geoengineering techniques can impact surface UV and tropospheric chemistry. The implied SRM technique is that of space mirrors, where the solar constant is turned downwards to emulate a blocking out of the sun's rays, the magnitude of which tuned to match the radiative forcing from 4xCO2 (this is the so called G1 experiment).

The authors present some "standard results" (e.g. spatial pattern of temperature changes) before discussing chemical and related impacts more thoroughly. Key results include how a cooling stratosphere couples with reduced water vapor to drive



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ozone increases in the G1 simulations. The G1 simulations also increase tropospheric ozone, driven mainly by reduced water vapor (reduced OH production) and UV penetration (due to higher stratospheric ozone). The authors also highlight that the reduced UV could be important for human health through reduced vitamin D production.

Overall, I feel that this study positively adds to the growing literature analyzing the impacts of geoengineering techniques. Composition and UV impacts have not been studied in detail, and, while the scenarios are not necessarily ideal (e.g. using pre-industrial levels of ozone precursors; as also noted by another reviewer), the authors note these weaknesses, and I think that it provides a good basis to compare future work against. In summary, I would be happy to recommend this for publication after the authors have considered my minor comments/corrections below (mostly very minor).

Specific comments (Page and line numbers refer to the original Word version)

P1, L14: Why italicize geoengineering?

P2, L1: "However, despite. . ." – I feel this sentence rather trivializes an extremely complex issue. It is not possible to just turn off CO2 emissions without all kinds of (non-atmospheric) consequences!

P2, L2: It's not just researchers talking about GE

P2, L16: Suggest: "The central problem. . ." -> "A major issue. . ."

P2, L18: Full stop after "Earth system" and then start a new sentence.

P3, L11: Might want to be clear how UV (or other GE-related factors) can influence surface ozone

P3, L26: "Finally, section 4. . ."

P4, L7: Ref for MetUM?

P4, L12: comma after MetUM



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P4, L15-: Refs for these models?

P4, L21-: Is aerosol chemistry included? Are there composition/climate feedbacks with CH4 and N2O? Clarify whether the photolysis scheme respond to clouds, ozone and solar flux?

P5, Sect 2.2: I would be explicit that the CFC levels are (presumably) zero in the simulations. Also, would any putative space mirrors be uniformly efficient at all wavelengths?

P7, L6: Delete “rather”

P7, L8: “heating by higher ozone levels”

P7, L11: “in G1, as discussed below.”

P7, L33: why is NOx higher? Temperature effects?

P8, L6-8: Is this because the BDC slows?

P8, L21: “As discussed in section 1, tropospheric ozone. . .affecting human health and air quality”

P8, L31: The photolysis reaction has a temperature dependence too (vibrational excitation), which further complicates things.

P9, L13-22: Do you have tropospheric ozone budget data to help with this analysis?

P9, L24: “in G1, as shown by the data in Table 2.” (A comma and then “see X” does not read well – there are other examples that could be addressed.)

P10, L3-14: I would remind the reader that the conclusions are based on simulations with PI conditions. Some of the impacts ($\Delta$T, $\Delta$humidty) will be important for trop chem in general.

P11, L16-19: You might be able to use data in Madronich (2007) to estimate the impact on vitamin D (he has empirical values for ozone/weighted-UV derived for lots of different action spectra). . . .However, if the simulations have PI ODS levels, is it really worth



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talking up the health impacts too much?

P14, L3: I would emphasize this weakness first. It's not terminal, but it is important. [You might be able to point to other studies that have investigated UV-tropospheric chemistry links to infer potential impacts if the ozone precursors were not at PI levels]

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Interactive comment on Atmos. Chem. Phys. Discuss., 15, 31973, 2015.