

Replies to comments by reviewer 2

Comment: Dear Editor, dear Authors,

The manuscript “Investigating the ability of satellite occultation instruments to monitor possible geoengineering experiments” by Lange et al. aims at analysing the expected capability of solar occultation instruments like SAGE III to detect and characterise stratospheric aerosol injection (SAI) geoengineering interventions. As said in first review stage, the topic of the manuscript is potentially important and relevant for a readership of satellite instrument and data scientists. During the first review round, I suggested to review the manuscript around 4 major comments and a number of minor comments. I think that, globally, the Authors satisfactorily clarified these points, even if the changes in the text are quite limited and somewhat incomplete. Thus, I propose to accept the manuscript for publication pending a few further minor changes, which basically are associated with further clarifying these 4 major points + 2 minor points, all detailed in the following.

Regards.

Major Comments:

1) OK got it. I agree that a continuous injection is different from point injection and worth testing in terms of detectability. Unfortunately, this is not yet fully clear from the Introduction/motivation (the proposed change in the Introduction is minimal), so please use more words to explicit this aspect and the underlying motivations of this study.

Reply: In the course of responding to the reviewer comments, we have already added the following to the introduction/motivation: “The aim of the current study is to investigate whether it is possible to detect stratospheric aerosols formed from small amounts (in context of possible geoengineering experiments) of sulphur artificially and continuously injected into the stratosphere. Here 1 and 2 Tg S/y, which results in a much lower sulphate injection per time compared to a volcanic eruption with the same injected amount, using a satellite solar occultation instrument, like SAGE III/ISS. ”

Nevertheless, we have added the following to the introduction: “Especially in view of the fact that the continuously injected sulphur amounts of 1 and 2 Tg S/y lead to much lower injection amounts per time compared to a volcanic eruption with the same amount injected.” (l. 44 – 46)

Comment: 2) Despite I don’t completely agree with this (AMT sound still more adapted than ACP, for me), I think this is up to the Editor to decide on this.

Reply: Thank you for the comment.

Comment: 3) Thank you for rewording the sentences I pointed at, this is clearer now. I’m still a bit confused on why ”the errors in the background case are larger [than in the initial phase of SAI deployment]”: please clarify this in the text

Reply: In the course of responding to the the reviewer comments, we explained this relationship below (l. 187 – 188): “...as the signal is stronger at a higher injection rate such as 2 Tg S/y and the total errors are therefore smaller.” To avoid possible confusion, we have added the following to the sentence in question, which refers to this sentence (l. 187 – 188): “It should be noted at this point that for the retrievals based on the initial phase data, the errors for the background case are used in the following, based on the assumption that these errors (relative differences) are larger, which is why an error analysis was also carried out for the background case (explanation below).”.

Comment: 4) The quality of the text and clarity is a bit improved, thanks for following my specific comments

Minor Comments:

1) Minor Comment 7: OK but did you modify the text to clarify this?

Reply: We have not adapted the text at this point, as it already says: ”The injection of sulphur dioxide into the stratosphere (stratospheric aerosol injection, SAI) is one idea of SRM (e.g., Budyko, 1977; Crutzen, 2006), mimicking the effects of large volcanic eruptions...” (l. 14 – 15).

And:

”SAI is supposed to be relatively cheap (e.g., Moriyama et al., 2017) and companies or start-ups may see an option to earn money with SAI (e.g, “Make sunsets” company (Make sunsets , 2024)). Therefore, it is very important to be able to observe relatively small amounts of sulphur aerosols in the atmosphere.” (l. 25 – 28).

Comment: 2) Minor Comment 15: OK but has this information been added in the text?

Reply: We added this information to the ECHAM chapter: ”The solar radiation scheme in ECHAM has 4 spectral bands, 1 for the visible and ultra-violet, and 3 for the near-infrared. The long-wave radiation scheme has 16 spectral bands (see Stier et al. (2005)). Values for single scattering albedo and asymmetry factor are taken from a look-up table, pre calculated with Mie calculations, to save computation time.” (l. 76 – 79).

Replies to comments by reviewer 3

Comment: Figures A2, A3 are not mentioned in the text of the paper.

Reply: Thank you for the comment. The figures are mentioned indirectly in the following sentence: "More Figs. for different latitudes can be found in the appendix." (l. 166 – 167). To make the statement clearer, we have added the following to the sentence: "More Figs. for different latitudes can be found in the appendix (Figs. A2, A3)."

Comment: Row 183 "he total errors at the altitude" should be "The"

Reply: Thank you, changed!