

To: Editor, ACP

Subject: Author Comments of Manuscript, acp-2022-370

Dear Dr. Jianping Huang,

Upon the recommendation, we have carefully revised the manuscript entitled “*Future dust concentration over the Middle East and North Africa region under global warming and stratospheric aerosol intervention scenarios*” after considering all the comments and suggestions made by the Referees; all the changes made in the revised manuscript are highlighted in yellow. The following is the point-to-point response to all the comments (the reviewers’ comments are rewritten in black color and the replies in blue). We appreciate the opportunity to revise our paper. We believe that the manuscript is much improved after positively addressing all the requested revisions. In the following we provide answer of Anonymous Referee #2.

Notice: The line and page numbers refer to the pdf file of “Revised Manuscript”.

Referee #2

This manuscript can go forward to publication, although there are still problems scattered throughout which should be corrected. The comments below note the ones I found. There may be others. My reading was somewhat quick, but I would not have expected even this much for a third revision. The ellipses below set off quotes from the manuscript.

We thank the reviewers for the comments and suggestions. We think that by implementing the reviewers’ comments and suggestions, the revised version has significantly improved.

19 ..., except over dust hotspots and for the dry season (e.g., summer with the 20 strongest dust events), which more reduction has been projected for the global warming scenario ... This phrase doesn’t make sense from “which”. End this sentence at ... events). Then start a new sentence with whatever the which ... is to imply. I can’t offer a suggestion as I don’t understand it.

Reply: considering the referee’s suggestion, the sentences are rewritten as following. Please see lines 19-22: This reduction in dust over the whole MENA region is stronger under the SAI scenario, except over dust hotspots and for the dry season. In other words, in the summer with the strongest dust events, more reduction has been projected for the global warming scenario compared with the SAI scenario.

42 ... from remote (what) ...?

Reply: this sentence is rewritten.

53 ... regional projections over West Africa projected ... Maybe try, regional predictions ...

Reply: Implemented

62 ... models which participated ...

Reply: Implemented

198 ... Overall, in Fig. 2e, the highest dust concentrations (up to 37 $\mu\text{g}/\text{m}^3$) are found ... What is the basis for this statement. The scale on Fig. 2e only goes to 30, and none of the lines even get close to this maximum. Oops I see the problem. The labels on the figures are in error. The bottom plot is 2f, not 2e as it is labelled now and led to the comment above.

Reply: Implemented

222-223 Doesn't this suggest that SAI isn't doing anything if there is no change with respect to the control? This should at least be acknowledged if not commented upon.

Reply: as mentioned in the manuscript, geoengineering is considered as the third pillar of climate change policy (alongside mitigation and adaptation efforts) to compensate for anthropogenic warming, and Stratospheric Aerosol Injection (SAI) geoengineering is one of the most discussed strategies. The amount of injection annually adjusts using a feedback-control algorithm to keep a) the global surface temperature, b) interhemispheric and c) equator-to-pole temperature gradients close to the year 2020 conditions (i.e., CTL scenario).

Fig. 5 figure caption ... total leaf are ...??? Change is misspelled in the figure label for the color bar.

Reply: Implemented

Figs. 5q and r. The authors make no comment on the fact that for TLAI RCP8.5 and CTL are at their maximum now and don't change in the future. While the big difference is that TLAI increases under SAI. This is difficult to understand. Isn't the CTL holding the climate state as it is in 2010 or so? Why isn't this reflected in a difference with RCP8.5, Fig. 5p.

Reply: as stated in the manuscript, the monthly and annual means (Fig. 5p and q) show the trends of mean values over the whole MENA region, for detailed analysis, it is better to see the

spatiotemporal anomalies of TLAI for the different scenarios. Please see lines 224-226: The TLAI under the RCP8.5 scenario shows 5-30 % reduction compared to the CTL across the different area of MENA region, except the region between the Mediterranean and Caspian Seas (Fig. 5a, d, g and j).

260 ...The box plot and monthly mean values of the precipitation from different scenarios (Fig. 7p) show that under the RCP8.5 scenario (compared to the CTL), precipitation is projected to almost a 20% increase during the summer season, and under the SAI scenario (compared to the CTL)... These differences are hardly significant. The three scenarios are almost all within their data ranges. Also this may be only true because the precipitation is so low to begin with, making this comment even less significant. The real take home is that for most of the year and throughout the century there is very little difference in the scenarios compared to the CTL.

Reply: although the three scenarios are almost within their data ranges for most of the months, the differences between the SAI and CTL scenarios are obvious for the spring season (i.e., April, May, and June). Also, the differences between the RCP and CTL scenarios are seen in August and September.

264 ... MENA region will increase by 5% under the SAI and RCP8.5 scenarios... Is this number even measurable considering the natural variation of precipitation? Again there seems little significant differences between the scenarios. That is the important thing, not small, immeasurable differences.

Reply: the sentences are rewritten based on the referee's suggestion as below, please see lines 263-264: It suggests that the mean annual precipitation across the whole MENA region has little significant differences under the SAI and RCP8.5 scenarios by the end of this century.

266-275 Same comment as above. The differences pointed out are hardly measurable, using Fig. 8q to discuss trends is a stretch, and the surprising thing is how little differences appear between the trends.

Reply: although, the difference in soil water between scenarios is little, it is measurable considering the data distribution and error bar in Fig. 8p and q. Furthermore, the spatiotemporal analysis, reveals the differences between the scenarios obviously.

291- ... the wind speed is the main parameter that affects dust concentration change ... This seems so obvious that it hardly needs to be verified with a model. Likewise precipitation.

Reply: as you mentioned correctly that is so obvious, nonetheless we want to show the most important factor for dust concentration changes between considered parameters.

Fig. 9 What is the difference between the two columns? One might assume that one is RC8.5 and one SAI but neither the figure caption nor the plots indicate what they are.

Reply: caption and title of the figure is corrected.

Fig. 10 Why isn't the CTL added to these plots so the reader could compare the impact of the two scenarios, not compared to each other, but compared with the current climate. The main take away from Fig. 10 is that aside from temperature and maybe TLAI the two scenarios hardly differ in their impact on all the other parameters. The CTL appears in Fig. 11 so it is available.

Reply: as described in the data and method section and presented in Table 2, CTL stands for the first 20 years (i.e., 2010-2029) of the RCP8.5 scenario. Figure 10 shows the annual mean values of the considered parameters for RCP8.5 (2010-2097) and SAI (2020-2100) scenarios.

299 ... approximately 20% and 10% reduction is projected for the SAI scenario over the R2 and R3 hotspots respectively (Fig. 10a2 and 10a3)... Perhaps this is a valid statement for 10 a2, but not for 10 a3 where differences between the scenarios are imperceptible.

Reply: the sentences are rewritten, and the referee's suggestion implemented.

330-335 Or the authors could say that the dust concentrations declined 5-30% under either of the scenarios tested, saving a sentence and drawing attention to the similarities of the two scenarios. But why is this so? According to Fig. 9 dust is correlated with temperature. So why isn't the dust less under SAI since there is a clear temperature difference between these two scenarios.

Reply: as written in lines 333-335, dust concentrations in the summer of the R3, R4, and R5 hotspot regions under the SAI scenario are approximately 5-15% higher than in the RCP8.5 scenario (Fig. 3i). So, there is a weak similarity between two scenarios. Although Fig. 9 shows some correlation between dust and surface temperature, over dust hotspots regions, the correlation coefficient values are small for both scenarios.

337-339 This is the explanation for the previous question that is probably correct and quite interesting. This point should be made early on in the manuscript as it provides a basis for better understanding of the results. And may also contribute significantly to the precipitation changes.

Reply: considering that the mentioned statement is not part of our results, we had to bring this sentence into the discussion section.

341 Shouldn't LAI have already been defined by now. It has been discussed since Fig. 5.

Reply: as the referee suggested, the explanation of LAI moved to the result section, before discussing it in Fig. 5. Please see lines 222-224.

363 ... R4 dust hotspot will encounter an enhancement in the annual precipitation (i.e., about 100% and 65% under both RCP8.5 and SAI simulations respectively), consistent with an increase TLAI index (i.e., more than 100% under both scenarios)... Why aren't these differences reflected in Figs. 5 and 7. According to Fig. 7 neither scenario shows more than a few percent difference in precipitation for R4. There is a precipitation increase of 10-20% just north of R4 for some months for SAI, but not RCP8.5. The maximum for the percent difference scale is 25 (30)% for precipitation (TLAI).

Reply: the R4 dust hotspot is located in a semiarid region with lower vegetation cover and precipitation rate compared with the northern part of the MENA region. So, the increases for R4 are not obvious in comparison with the vegetation and precipitation of the southern Europe in Fig. 5 and Fig. 7. However, the annual mean values over the dust hotspots (Fig. 10) reveals the changes more clearly.

372-374. This conclusion seems so obvious that one shouldn't need a model to make that statement.

Reply: as you mentioned correctly that is so obvious, nonetheless we want to show the most important and correlated factors for dust concentration changes between considered parameters.