Response to the Anonymous Referee #2:

This paper is a straight forward comparison of predictions of model ensembles using one model with two scenarios, global warming (RCP8.5) and stratospheric aerosol injection (SAI), over 80 years compared with a control run of 20 years. The variable of interest is dust and its correlation with surface temperature, leaf area index, precipitation, soil moisture and wind speed. The region of interest is north Africa and the middle east with various dust hot spots identified. The bulk of the paper rests on describing Figs 3-9 which show the spatial and temporal variation of each of these parameters under the two scenarios for monthly and annual means. The spatial differences are shown variously and absolute value or percentage depending on the variable. It is not clear why they are not all shown as percentages.

Reply: 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.
In this investigation plots of absolute changes and percentages of changes have been plotted for all investigated parameters. In addition, a plot with a better description for each parameter is included in the article. We agree that showing percentage change is helping to visualize both areas changes in dust hot spots. However, for regions with very small background concentrations, for example for Europe or regions with less than 5 ($\mu g/m^3$), and even a 50 or 100% change in dust, relative changes do not make sense (Fig. 1).

The authors then make some conclusions about the differences between the RCP8.5 and SAI scenarios, a number of which are difficult to believe if the error bars are included in the discussion of the annual differences or trends in for example soil moisture, wind speed.

Reply: considering your great suggestion, and for statistical analysis we added box plots (i.e., percentile values of standard deviation) to the monthly mean values. Furthermore, we depicted the standard deviation values of all available ensemble members (indicated by shaded envelope) in the annual mean value and other trends. The new plots including errors would give a better sense to readers of the statistics of the parameter changes under different scenarios. As mentioned in the text (previous version of the manuscript), the error bars plotted on the annual time series indicate the parameter's minimum and maximum value in that year. In the new version, the standard deviation (indicated by the shaded region) is used instead of the minimum and maximum.

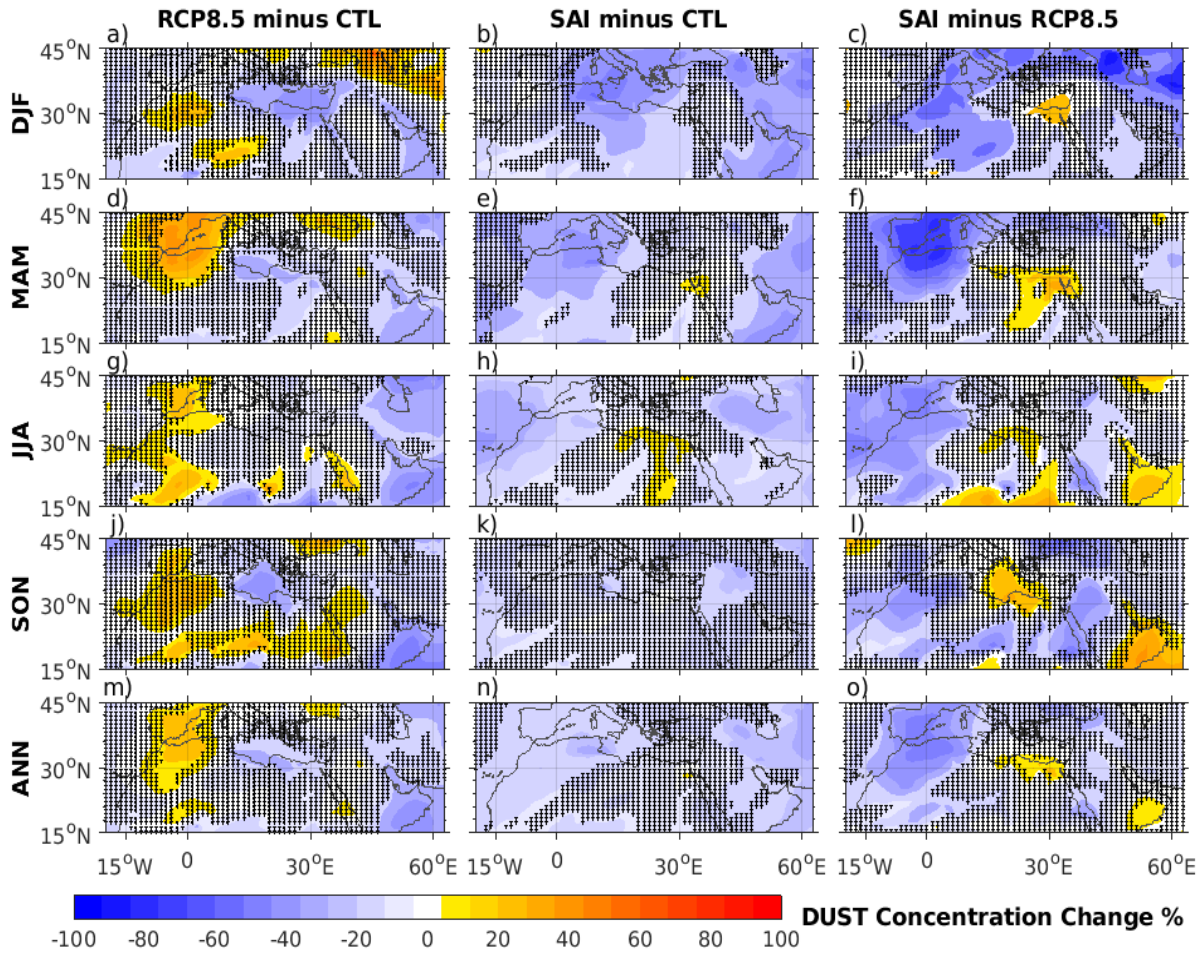

Figure 1: (a-o) Seasonal and annual changes of dust mass concentration mean value in the MENA region under different climate scenarios. All available ensemble members of the GLENS project are used to calculate mean value of dust concentration for CTL (2010-2029), RCP8.5 (2078-2097) and SAI (2078-2097). The regions without hatch line shows student's t-test analysis with 99.9% significance level.

Error bars should be included on all the figures showing mean values: monthly, annually, or spatially. Currently error bars are included only on the annual means. The same should be to Fig. 10. Then the authors discussion of notable differences can be placed in the context of how well any one variable is known.

Reply: As mentioned above, the error bars have been considered for all of the monthly, annual, or spatial analyses using shaded region or box plots. Moreover, considering referee 1 comments and suggestions, we replaced Fig 10 (in the previous version) with two new figures Fig. 2 and Fig. 3 of the text (i.e., Fig 11 and S1 in the new version) and related sentences in the context are revised.

One of the results which is rather striking, but which the authors largely ignore, is how little difference there is between the various variables, except for surface temperature and leaf area index, for the two scenarios, see e.g., Fig. 10. Similarly for most variables there is primarily little difference between the two scenarios and the control. Isn't this surprising given one scenario is global warming as usual, whereas the other is to deal with global warming. Are we to conclude that only primarily temperature will be affected?

Reply: The little difference you correctly pointed out in Fig 10 (previous version), could be the result of spatially averaged over the large area of MENA and the Middle East. The new figures of multi-monthly mean values with error bars Fig. 2 and Fig. 3 of the context (i.e., Fig. 11 and S1), alongside the contour plots over dust hotspots shows considerable differences between different scenarios more clearly and shows that the change of dust concentration over the hotspots is influenced by changes in the surface wind speed, precipitation, and vegetation cover (Please see Fig. 2, 3, 5, 7, 11, and S1 in the manuscript).
Moreover, using the atmospheric dust mobilization scheme, the surface temperature does not participate directly (see equation 1), so, we investigated five parameters that can directly or indirectly contribute to dust events to find the most effective variable for decreasing the dust concentration in this region. By the end of the century, the average temperature remained constant at the 2020 level in the geoengineering scenario, and for the RCP8.5 scenario, approximately 6 degrees increase in temperature was projected for the studied area. At first glance, the increase in temperature causes lower soil moisture and, subsequently, more probability of the formation of dust event. While for both scenarios, despite the temperature remaining constant or increasing, dust reduction has been projected over the studied region.

The paper would be improved if some discussion along these lines was added and if the authors treated the supposed differences and trends more carefully to put them in the context of the uncertainty in the knowledge of variable in question. If differences or trends are small fractions of the uncertainty, there cannot be much confidence in such predications.

Reply: As you suggested the error bars are considered for all analysis. Moreover, to decrease the uncertainty in mean monthly and annual trends, we investigate these trends over dust hotspots instead of entire MENA and Middle-East regions.

More detail on these and other points follow in paper order, including a couple of minor points.
44 From remote "regions?"
Reply: this sentence means is "MENA cannot receive humidity transferred from other regions".

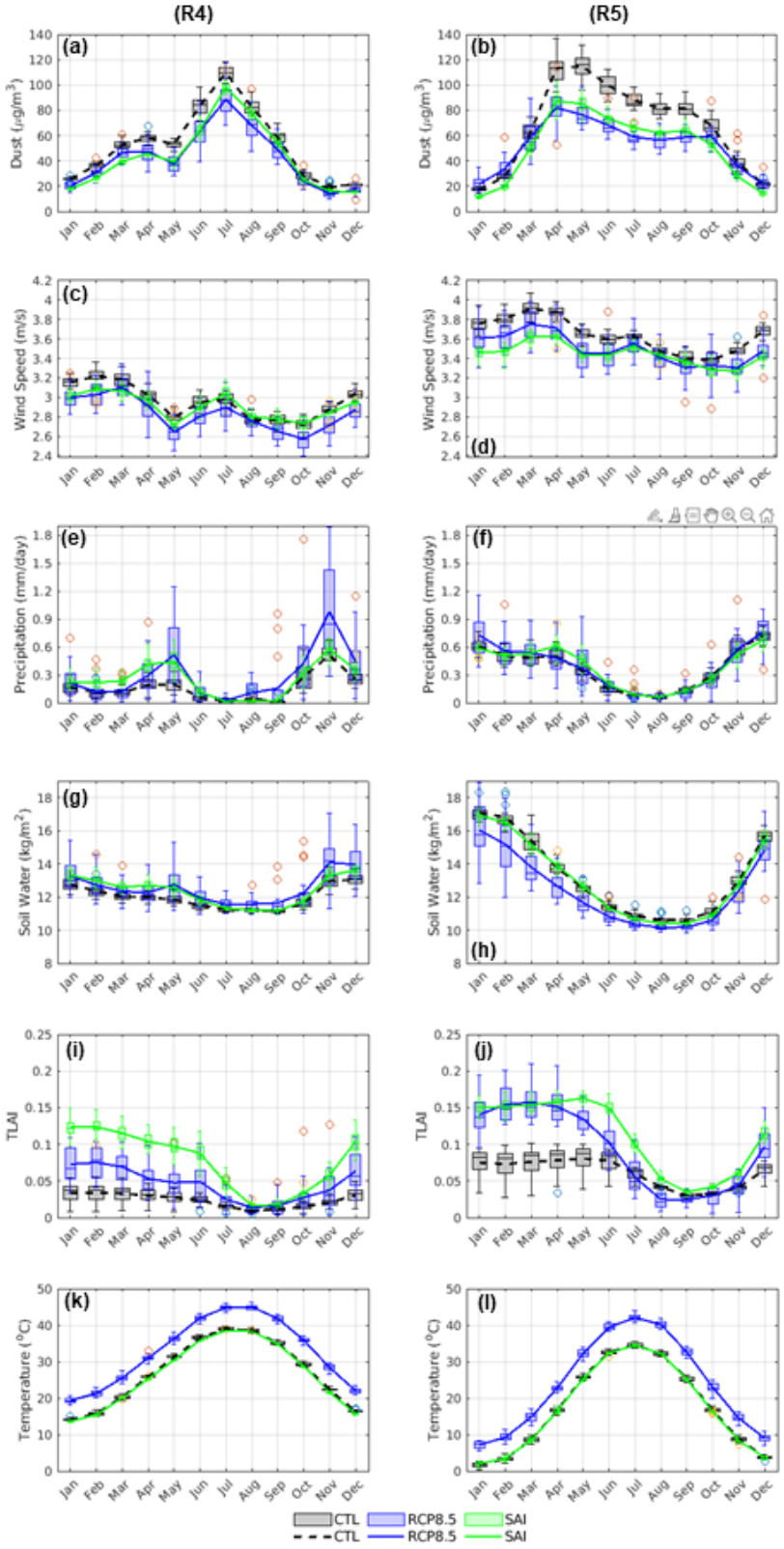

Figure 2: The multi monthly mean values of the considered parameters with percentile values as error bars for R4 dust hotspot (left column) and R5 dust hotspot (right column), for different scenarios. The box plots are depicted with the median (horizontal line), the 25–75 percentile (box), the 5–95 percentile (horizontal line), and outlier data (circle).

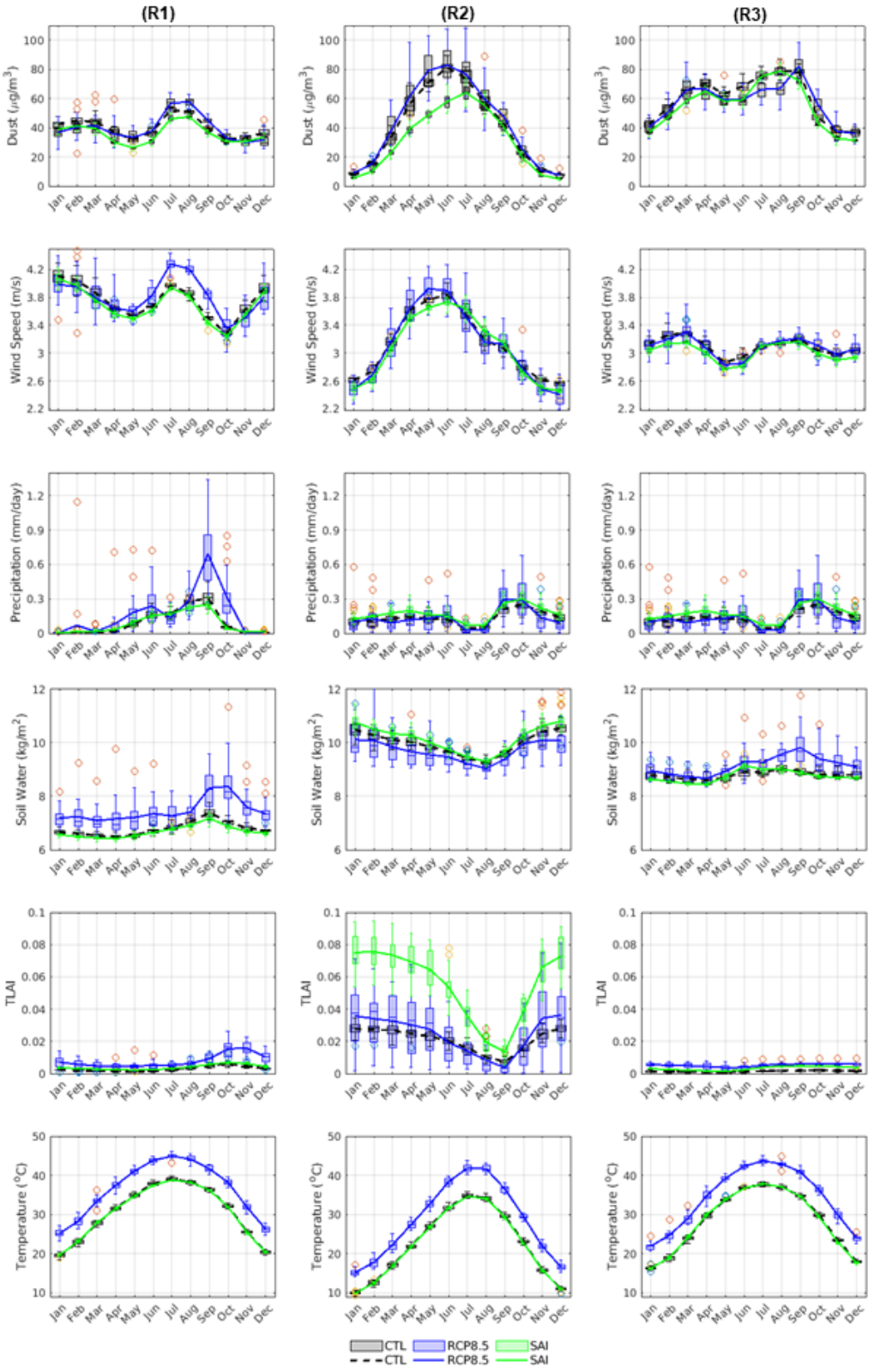

Figure 3: The multi monthly mean values of the considered parameters with percentile values as error bars for R1, R2 and R3 dust hotspots, for different scenarios. The box plots are depicted with the median (horizontal line), the 25–75 percentile (box), the 5–95 percentile (horizontal line), and outlier data (circle).

80 dioxide
Reply: is implemented.

166 Isn't it the cumulative LWTC averaged over time? Or is there a new variable WTC?
Reply: in response of Referee 1, and to show the correlation of dust concentration with considered variable we replace this figure (Fig. 2 of the previous version) with new figures.

Fig. 2 Some general comments should be made to explain the similarities of all the figures no matter the variable being correlated, particularly for readers not accustomed to such plots. For example, why is there always a strong annual cycle? Is this just the strong annual seasonal cycle? Why is there a definite semicircle traced out delineating the bright and dim colors in all plots? Is this an issue with the period versus the year, i.e., there can't be an eight year correlation for times less than 16 years beyond the start date? Presumably this is the cone of influence. But if that is the case why are there any correlations outside this cone shown on the figure?
Reply: as mentioned above the Fig. 2 and sentences related to wavelet coherence are removed.

Fig. 2 caption is unclear. 1) Isn't the cone of influence denoted by the more intense colors? If that isn't the case then it suggests the cone of influence is only from 2-20 years before 2050 and after 2070 with no influence in the center of the figure? 2) What is meant by the whole MENA region. Is that different than the MENA region? Also in the text line 199, and similarly confusing whole middle east. These regions were defined clearly earlier, now there seems to be a confusion about what they mean.
Reply: as mentioned above the Fig. 2 and sentences related to wavelet coherence are removed.

218 Again the whole MENA compared with the Middle East. Is this now not the whole Middle East?
Reply: as mentioned above the Fig. 2 and sentences related to wavelet coherence are removed.

Fig 3 c-q. Consider using percentages. The average reader may not know if 45 ug/m^3 is a lot or a little. But checking Figs 3a, b indicates that 45 ug/m^3 is 50-100% above or below the mean value, so it is a lot.

Reply: as mentioned and depicted above in the Fig. 1, if we use the percentage for the dust concentration, a decrease or increase of 50% or more are shown for some regions in Europe with no dust hot spots. For more explanation we added the following sentences to the discussion section;

lines 305-313: As our analysis reveals, the reduction of the future dust mass concentration over the MENA region (in both of the RCP8.5 and SAI scenarios) are mostly due to the weakening of the Middle East dust hotspots (Fig. 2 and 3). Moreover, the highest dust concentration of each year occurs over the Middle East during summertime (Fig. 2f and g). The reduction rate of the dust concentration is about 5-40% for the RCP8.5 scenario (compared to CTL), where it is stronger from March to September, especially for the dust emission in the Middle-East region (Fig. 2a, Fig. 3d, g, and j). Similarly, the dust concentration is also found to decline under the SAI scenario compared to CTL (Fig. 3b, e, h, and k) over the whole MENA region. Dust concentrations in the summer of the Middle East and Northeast Africa (i.e., R3, R4, and R5) under the SAI scenario are approximately 10-30% higher than in the RCP8.5 scenario (Fig. 3i).

Figs 6-9 q) which depict the annual mean value. Don't all of these figures, except fig. 6q) show that considering the error bars there is no difference between RCP8.5 and SAI. The difference in the means is a small fraction of the range of differences mapped out by the error bars. The differences shown in the monthly mean value figs p) appear at first more significant, but where are the error bars on this figure? If they were included the picture might be just as difficult in concluding a difference between RCP8.5 and SAI. Of these figures the only two that show a distinct difference outside the error bar range are surface temperature and TLAI.

Reply: As mentioned before, we considered error bars for all monthly and annual trends. As depicted in Fig. 2a, b and also Fig (5-8) p and q, the monthly and annual differences of the scenarios are seen. For example, Fig. 5p, q and r, clearly show that the TLAI increased significantly under the SAI scenario, and also the model projected an enhancement for the TLAI during winter and spring under RCP8.5. On the other hand, according to the algorithm implemented in the GLENS project, the considerable difference in temperature between the SAI and RCP8.5 scenarios is acceptable. Moreover, to reduce uncertainty we focused on the dust hotspots instead of the MENA region. The error bars on monthly mean values and annual trends in the Fig. 2-8, alongside the new figures (i.e., Fig 10, 11, and S1), depicted the difference between scenarios more clearly.

Thus the authors conclusions such as at lines 311-, "Figure 7q further shows … and under SAI, the wind speed reduction is gradually stronger than RCP8.5 starting from 2050.", or 324, "Fig 8q shows that a moderate positive trend of the annual mean value exists in the soil moisture under the SAI scenario." are deeply flawed. There is no trend that would stand under any statistical test given the size of the error bars on the data. The authors must be much more careful about what can be concluded from these monthly and annual mean values.

Reply: considering your great suggestion, and to investigate the statistics on monthly mean values, we include error bars on monthly variations plots, and tried to rewrite and update the

manuscripts regarding new plots with error bars (Fig. 11 and Fig. S1). These figures are discussed in on the manuscript on line: 282-290 as a below:
"Figure 11 included error bars for monthly mean values of all considered parameters for R4 and R5 regions, and shows considerable reduction of dust concentration between the control and the two future scenarios for both regions in spring to fall with the stronger differences for R5. Differences between RCP.85 and SAI are however not significant. The monthly mean values with error bars of all considered parameters for R1, R2 and R3 regions are also shown in Fig S1. The reduction of the monthly mean value of dust concentration over the R4 region (Fig. 11a) may be a result of the increase in precipitation (Fig. 11e) and soil moisture (Fig 11g) the decrease in wind speed (Fig. 11c). Moreover, it seems that the reduction of dust concentration over the R5 region (Fig. 11b) is mainly controlled by the lower wind speed (Fig. 11d) and higher leaf area index (Fig. 11j). The results of Fig. 10 and Fig.11, are in good agreement with the results and correlation coefficients in Table 3."

Similar comment can be made about Fig. 9r), a slight difference appears in the mean values east of 50 degrees, but would this appear significant if the error bars were included on this figure? The error bar range is on the order of plus/minus 100 mm/year.

Reply: We considered the statistical analysis for your mentioned figure for all available ensemble members and depicted in new version in the Fig. 7r. In the previous manuscript, the error bar in annual trends indicated the maximum and minimum of parameters and it replaced by the standard deviation of the annual mean values for different ensemble members in new version. The model simulates an annual mean of the precipitation almost 220 (mm/year) over the entire MENA region for the CTL scenario (Fig.7q). For longitudes > 40 ^{o}E (i.e., in the vicinity of R4 and R5), the differences between the RCP8.5, SAI, and CTL scenarios is about 20-50 mm/year (Fig. 7r). This means that mentioned region receives 10-25% more precipitation in the future climate and this is a considerable amount for this semiarid region.

Fig. 10. Error bars should be included on this figure, just as they have on all the annual means shown. This is needed to put the differences noted in the context of the overall uncertainty in the predictions.

Reply: As you suggested the error bars are included in the monthly mean values. Moreover, to decrease the uncertainty in mean monthly and annual trends, we investigate these trends over dust hotspots instead of vast MEAN and Middle-East regions. Please see Fig. 2 and 3 (Fig. 11 and S1 of the new version of the manuscript).