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Comment on acp-2022-370

Anonymous Referee #1

Referee comment on "Future dust concentration over the Middle East and North Africa region under global warming and stratospheric aerosol intervention scenarios" by Seyed Vahid Mousavi et al., Atmos. Chem. Phys. Discuss.,
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The paper presents a study of future dust concentration in the MENA region under the RCP8.5 scenario and a corresponding geoengineering experiment designed to keep the global temperature at 2020 levels. The experiments used are from the ensembles generated under the GLENS project. The paper first present a cross-coherence analysis between dust concentrations and variables like temperature, precipitation, soil-moisture etc. It then goes on with a detailed presentation of the changes in the different variables in the RCP8.5 scenario and the geoengineering scenario at the end of the century.

I think the topic is interesting and a study of the changes in the future should be welcomed. However, I think the conclusions from the cross-coherence analysis are questionable and I find that the rest of the paper is too much of an 'atlas' over the changes and don't really answers the questions of what factors that drives the changes in dust concentrations. Because of these concerns, I can't suggest that it is accepted in its present form.

Major concerns:

a) The cross-coherence analysis:

I don't find that the method is very well explained in section 2. What are the connections to the axes in Fig. 2? How do you come from the equations to the quantities (amplitude, phase?) shown in the figure? More importantly, I am also confused about the physical interpretation. There are probably annual cycles in all meteorological variables. This means that there will always be coherence between them. As the annual cycle probably is different from a pure sinusoidal, there will also be a signal at 1/2-year. So what do we actually learn from Fig. 2? In the discussion section (1365) it says that the dust is 'substantially influenced' by the changes in the other fields. But I don't think you can conclude that from the analysis. What we learn is only that there is an annual cycle in all the fields including the dust but nothing about the physical interpretation.

b) The rest of the paper seems to me to be too much focusing on presenting the details about the changes in the different fields. I think many of the panels basically shows the same and that the number of plots and panels could be reduced. I really miss some solid analysis and results about what drives the changes in the dust. The dust generally

decrease in the RCP8.5 scenario but it decreases further in the geoengineering scenario. Perhaps I am missing something but I could not find an explanation. The correlations in Table 3 could be a beginning, but the physical connection between the variables requires that the trends - which I guess determines most of the correlations here - are removed.

Minor comments:

l54: reginal -> regional

l97: So this is an ensemble based on a single climate model? How are the different ensemble members generated?

l103: What is 'interhemispheric temperature gradient'?

l115-130: Is this a new method adopted for the present study? Is it described in the literature before? If it is new perhaps it should be described in more details and more background given. As it is now it is not transparent for me. For example what is a transport bin?

l148: composite analysis? Is this the right word? You calculate the difference of temporal means.

l160, Table 3: Are the correlations averages over all the ensemble members? It should be mentioned in the caption that this is annual means.

As mentioned I have problems with the presentation of the wavelet coherence.

In line 171 why is $[(n'-n)dt/s]$ the complex conjugate? Is ω_0 a constant? If it is how is it selected?

l172: The sentence 'In this approach .. ' seems misplaced here and should be moved down near line 184.

More importantly in Fig. 2 the coherence is shown as function of time (x-axes) and period (y-axes). It is not clear from the text what these correspond to in the formulas.

Furthermore, the figure caption mention both the power and the phase which is not described in the text. The same goes for the cone of influence.

Eq. 6: Should there not be some smoothing here too?

The discussion of Fig. 2, page 7-8:

It should be pointed out more specifically in the text that Fig. 2 is for SAI. Does it look the same for the RCP8.5? Why focus on the SAI here?

The 22-years variability and variability larger than 16 years seems to be outside the cone of influence. Also, it is not significant in the GWTC. In general the two regions in Fig. 2 look identical to me. I don't think you can say that there are significant differences.

And I don't really see any change after 2040. Perhaps just presenting the GWTC would be better.

I207: 'Out of phase'. Does this mean -180? Is it just difference in sign?

I246: How does this indicate that the model is consistent with observations? There are no observations used in the present study.

Table 3: Why the big difference between RCP8.5 and SAI for temperature correlations? Is this table only discussed in I258?

Section 3 should be split in two or more subsections. Perhaps not start with the coherence?