Atmospheric
Chemistry
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Discussions

Interactive comment on "Improved representation of the global dust cycle using observational constraints on dust properties and abundance" *by* Jasper F. Kok et al.

Anonymous Referee #2

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The authors present a modelling approach based on an inversion model that includes a multi-model ensemble. With their approach the authors aim at improving the representation of the global dust cycle in global climate models.

The manuscript is well written; however, it is quite lengthy. I appreciate that all aspects are explained in detail, nevertheless, I think the manuscript would benefit from overall shortening.

Not all references are listed in the section References. Please complete.

General remarks I wish the authors to comment on:

(1) In order to apply the inversion approach, the authors separate the world (excluding high-latitudes) into 9 regions, across which the dust load is averaged. Although I understand that following such a procedure reduced the computational cost, I am wondering up to which degree this approach fosters obtaining the expected results (with regard to the observations) for the wrong reason. In particular as some atmospheric processes controlling dust emission and dispersion may cancel each other out.

(2) Can you elaborate in more depth in which way you see the general applicability and future potential of the presented modelling approach? I am wondering how feasible it is for a use in practise. The here presented study involves a 5-year period from more than 10 years ago (2004-2008). Not every model ensemble involved provides all necessary variables over the entire time period. Furthermore, 6 different model simulations are involved, not all of them freely accessible.

(3) Following on remark (2), how consistent is study if for some variables all model ensembles are used and for others not?

(4) Aren't the individual ensemble models as well as the MERRA2 data set somehow "tuned" towards similar observation data sets? In other words, how independent is your "independent" data set? This general comment refers in particular to section 4.1.

(5) Unfortunately, the methodology and results as presented in current form, seem to not contribute to a overall improvement of dust production models or their underlying conceptual understanding. Rather, the inversion model seems to reflect the consensus view across all models. What can the science community learn from this approach? I am sure there is something we can learn from this approach. Maybe this can be presented in a more prominent and obvious way?

(6) The physical consistency of dust emission flux calculations and dispersion with atmospheric conditions which then results into a dependent dust aerosol optical depth seems to be circumvented by this approach here. Can you comment on how physically consistent the overall representation of the dust cycle and its associated feedbacks is?

(7) Furthermore, as the individual model ensembles use different parameterisation schemes for various processes ultimately determining the dust cycle, I am wondering if this is an advantage here as diversity is reflected, or a disadvantage as it ignores physical consistency for the multi-model average. Please clarify.

(8) Where do you see the benefit of applying an inverse model over satellite data assimilation or a common ensemble mean?

Specific comments:

Line 26: Is this an "improved representation" of the global dust cycle or an averaged representation as it reflects the consensus view across all model ensembles? Please clarify.

Line 52-71: Across this paragraph, the need for an as accurate as possible representation of processes driving and controlling the dust cycle is illustrated. However, isn't this, the relevance of process-driven parameterisation for improving the representation of the dust cycle, ignored by the approach suggested here? In particular as averaging may result into cancelling out relevant processes.

Line 313-317: I am wondering if this is only applicable to coarse grid model simulations which would not be able to capture fine-scale dust plumes anyway. Please comment.

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