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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Dust Constraints from joint Observational-Modelling-experiMental analysis (DustCOMM): Comparison with measurements and model simulations" *by* Adeyemi A. Adebiyi et al.

Anonymous Referee #2

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This study presents a new dataset, the Dust Constraints from joint Observational-Modelling-experiMental analysis (DustCOMM), which combines in-situ measurements, reanalysis products, and an ensemble of six global model simulations. Particularly, globally-averaged dust size distribution and extinction efficiency from observational and experimental data are used to constrain the DustCOMM products. The annual and seasonal mean products of 3-dimensional (3D) dust size distribution, 3D dust mass extinction efficiency, and 2D dust loading are provided for the time period from 2004 to 2008. It is found the dataset shows a better agreement with measurements than the

six-model ensemble in terms of dust size distribution and mass extinction efficiency. This dataset may be used to constrain dust simulation in global models and to study dust impacts on the earth system. The paper is generally well written. The methodology to develop the datasets is thoroughly introduced and related uncertainties are also discussed in detail. I have a few comments would like the authors to address.

Major comments:

1. Here globally-averaged dust size distribution is used to obtain 3D dust size distribution. Is it possible to demonstrate that the regional differences in dust size distribution are small? Or have you considered using different dust size distribution for different regions, e.g., by applying regional averaged values to areas where individual measurements are available and the globally-averaged value to areas where measurements are not available? This might provide better spatial constraints on the dataset. Similarly, globally-averaged dust extinction efficiency at 550 nm is used. How large are the spatial differences? Is it possible to give a rough estimation based on available data?

2. As discussed in the paper, dust aerosol optical depth from the reanalyses largely depends on the models' treatment of the dust cycle, and this adds uncertainties to the DustCOMM. I wonder if you considered using satellite products of dust optical depth, such as level 3 dust optical depth from the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP).

3. Sections 4-5 show that the new dataset has a better agreement with in-situ measurements than the multi-model mean. I think it is better to add some discussion to emphasize why this dataset is a good complement to the currently available observational data, especially individual measurements. For instance, the global coverage and vertical distribution of the dust size distribution and mass extinction efficiency of the dataset make it easier to be adapted to global models to constrain simulations or to study global dust impacts.

Minor comments:

1. Lines 21-23, page 2, this can be a bit misleading since both small are large dust particles absorb and scatter shortwave and longwave radiation.

2. Line 6, page 3, “To address this problem”, not sure the dataset would be able to address the “numerous important biases”. You may want to point out a few detailed problems.

3. You may want to add the horizontal and vertical resolutions of the DustCOMM product at someplace in Section 2.

4. Line 17, page 11, what time period does the “climatology” refer to?

5. Section 3.1, are all the model results interpolated to the same horizontal and vertical grids? And what’s the resolution?

6. Line 35, page 16, why the JRAero in a different time period is used? It’s not available from 2004 to 2008?

7. Line 16, page 21, do you refer to Fig. 4 instead of Fig. S4?

8. Line 16-18, page 21, can you please add some discussion about why the DustCOMM has a larger bias than model ensemble for D $\leq$ 0.5 μm?

9. Line 19-24, page 23, “...regardless of the season and location”, except Sde Boker, Israel.

10. Table 1, please remove “deg” in column four, since you already added a degree symbol there.

11. Figs. 2-3, can you please add latitude, longitude, and location of the measurements on the top of each plot? Or you may number the measurements listed in Table 2 and then simply list the corresponding numbers in the figure.

12. Fig. 5, is it possible to add a globally averaged PSD and its PDF to the plot?

13. Fig. 6, why is dust mass fraction for D= 0.2-2.5 μm high over the ITCZ? Is this

consistent with observations?

14. Fig. 7, it would be more interesting to show individual model results (as in Fig. 5) instead of multi-model results.

15. Fig. 8, why do some blue dots have a light blue outline?

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