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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Direct radiative effect of dust-pollution interactions" *by* Klaus Klingmüller et al.

Anonymous Referee #1

Received and published: 11 December 2018

This work described how the mixing of dust and pollution aerosol changes dust optical and radiative properties by increasing its extinction and reducing its absorption. Furthermore it quantifies the change in radiative effect of natural dust at the top of the atmosphere, at the surface and in the atmospheric column. A short discussion of regions where the mixed dust cools or warms the atmosphere over 4 regions is also included. To be worthy of being published in ACP, this paper needs to give a reasonable amount of details on how the dust cycle is treated, what are the assumptions under which acids can be uptaken by dust and give the limitation of the optical properties derived by mixing dust with other aerosols. Here are the elements to add to this work to place it in the context of what has already been published on dust.

Ridley et al., 2016 and Kok et al. (2017) that you cite have established constraints

on the dust cycle using both satellite observations and 3 independent models. Please state tha amount of total yearly emissions, the yearly mean total optical depth and total deposition flux of dust in your model and compare them to these constraints.

How do you represent the particle size distribution (PSD) of dust. The PSD has a large influence on the value of your LW radiative effect. You should state how large a particle you represent and what fraction of dust particles suspended are PM1, PM10, or above 10 microns for example.

Then, when you account for the uptake of acids by dust, please state which acids, which chemical species you consider, and what accommodation coefficients were chosen. No need to refer the reader to another paper, a simple Table can go a long way to help the reader navigate through your assumptions of uptake coefficients.

Other major points include:

- Page 2, between the 2 last paragraphs of this page it would be welcome to state the main questions that you are trying to answer in this paper. After reading the introduction, the reader should be fully aware in what directions the paper will take him or her.

Page 3, line 26: The reader needs to know what refractive indices you took for dust both in the SW and in the LW, please state simply your reference for them and whether these refractive indices are coherent with AERONET observations or indicate a dust that is too absorbing compared to these measurements.

Page 3, line 26. You state that you assume spherical particles and make an hypothesis of volume averaged refractive index when mixing particles. There is abundant literature that this approximation in invalid and that a dielectric or a Maxwell-Garnett approximation describes better the state of mixture of an aerosol. State why you made this choice and what is the error associated with it.

Minor points:

In the abstract please state that you treat both dust radiative effect both in the SW and LW range of the spectrum.

A Figure showing as a function of wavelength the refractive indices used separately for the SW and LW would be very useful to the reader.

Page 5 line 20: could you find any field measurements that could guide you as to whether the hygroscopic variations of dust that the model represents are well captured?

Page 7 line 8: typo Change: "The distribution of the bottom of the atmosphere (BOA) forcing (Fig. 4, bottom) is similar to the that of the TOA forcing," with "The distribution of the bottom of the atmosphere (BOA) forcing (Fig. 4, bottom) is similar to that of the TOA forcing,"

Page 7, line 25; I am expecting that for region 1 Figure 5 would show a cooling effect for the atmospheric column. On this Figure, the heating rates are positive at almost all heights, how one can reconcile this fact with an overall cooling effect?

Page 8, lines 11 and 12: please give separately the contributions of the SW and the LW to the pollution free dust radiative effect of -0.08 W .m-2 and to the polluted dust of -0.13 W .m-2.

I believe that this paper can be vastly improved if you account for these recommendations.

References: Kok, J. F., Ridley, D. A., Zhou, Q., Miller, R. L., Zhao, C., Heald, C. L., Ward, D. S., Albani, S., and Haustein, K.: Smaller desert dust cooling effect estimated from analysis of dust size and abundance, Nat. Geosci., 10, 274–278, https://doi.org/10.1038/ngeo2912, 2017.

Ridley, D. A., Heald, C. L., Kok, J. F., and Zhao, C.: An observationally constrained estimate of global dust aerosol optical depth, Atmos. Chem. Phys., 16, 15097-15117, https://doi.org/10.5194/acp-16-15097-2016, 2016.

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