

Interactive comment on “Evaluation of natural aerosols in CRESCENDO-ESMs: Mineral Dust” by Ramiro Checa-Garcia et al.

Anonymous Referee #3

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General comments:

This manuscript presents the results of five Earth System Models simulations of the global dust cycle, emissions, dry and wet deposition, optical depths, and surface concentrations comparatively to satellites and in situ observations. The authors explore global and regional variability between models in three different simulated experiments: PD (calculated winds), PDN (reanalyzed winds), and PI (prescribed chemistry and aerosols). Overall, the manuscript is well written and provides ample content. Having said that, this manuscript is quite extensive and important information is left for the reader to find in the supplement. The content of this manuscript could be divided in two different publications. In the first one, you could explore the differences between the five models, and then, in the second, you could explore more deeply the differences

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between the three simulated experiment scenarios. At least, I would include a figure of the particle size distributions used in each model into the main text.

Specific Comments:

Page 6, Line 7-31: For this part of the text, it would be very useful to have a plot overlapping the particle size distributions in each of the 5 models. This would be similar to what you have in the bottom panel of Figure 4.

Page 7, Line 11: “Therefore those optical properties are representative for the global mineralogical composition rather than a description of the soil-type dependence of the mineralogy that would imply local differences on emitted optical properties.” The point you are raising here is important, but it is still not clear what optical properties you have actually used. For instance, do all five models use exactly the same spectral complex refractive indices? Which databases/references are you using in each model?

Page 3, Table 1: It would be useful for the reader to include the specific particle size ranges used in each model simulation in column DPSD. Alternatively, you could move Tables S.MD.8 and S.MD.9 from the supplement to the main text. Please, also include the meaning of PD, PDN, and PI in the title of Table 1.

Page 8, Line 2: “A last simulation where aerosols and chemistry emissions are prescribed for 1850 (named PI)”. Why? Could you add a few words explaining why such simulation is relevant and how do you use its results specifically in this study, covering the years between 2000 and 2014?

Page 12, Line 3: Could you please clarify the criterion used to select optical depths? What does “all – aer” mean here?

Page 15, Figure 4: What do you mean by “samples are the marks on x-axis”? Does the “sample” correspond to a given year? Which are the years you consider here? Include the time-period in the figure caption.

Page 22, Line 21: Could you clarify if the model simulations were sampled at MODIS

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and MISR times in Figure 4? What is the main reason for having UKESM's AOD so high?

Page 22, Line 29: Do you know why the EC-Earth and the NorESM have MEE values that differ from the other models? If so, I suggest you to discuss the main reasons in the text.

Page 23, Line 7 to 24: The plot overlapping all size distributions would again be helpful here.

Page 28, Line 7: "On the side the modeled wind surface friction velocity and speed agree better with actual meteorological conditions, and on the other side the description of the soil surface properties has become more accurate." These are important points. Could you provide references of experimental studies that support these two statements?

Page 30, Line 26: "... they indicate that although there are important differences between PD and PDN experiments in terms of total emissions, ...". It is difficult to see those differences here. Although it might be out of the scope of this paper, I think it would be interesting to comment on how the re-analyzed wind fields in PDN differ from the calculated wind fields in PD near dusty regions. Are there significant differences between the wind fields in PD and PDN? How much would be that difference?

Page 35, Line 22: "All the other models underestimate total depositions fluxes over stations where fluxes exceed 100gm-2yr-1." What do you think is the main reason for that?

Page 44, Line 7 to 30: Could you comment on the temporal resolution of the surface concentration observations? Are those monthly means based on continuous daily observations? Are these observations for one or the average value for multiple years? Include the years of the observations and the simulations in the figure caption.

Technical Corrections:

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Page 8, Figure 1: The aspect ratio of the Figures 1a and 1b seems strange.

Page 14, Line 27: Replace "has" by "have".

Page 16, Line 25: Replace "in the main paper" by "this paper".

Page 17, Table 6: Explain the meaning of "in and out".

Page 33, Line 11: "Figures Dep.11 and Dep.12 show ...". I cannot find these figures.

Page 44, Line 25: "situation"

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