

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

Anonymous Referee #2

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In this manuscript, the authors examined the simulated dust cycle by five Earth System Models. They compared the simulated the dust dry and wet depositions, dust surface concentrations, and dust optical depths against measurements across the world at both annual and seasonal scales. Their results confirmed what’s known to the dust research community, including that (i) the cutoff maximum dust size is important to the dust emission magnitude, and (ii) the ratio of dry to wet depositions is highly divergent between models. Furthermore, the authors found what’s less known to the dust research community, including that (i) using identical nudged winds among models can improve the consistency between models in the dust cycle, and (ii) the divergent mass extinction efficiency between models explains why similar dust loads result in a large difference in optical depth.

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I agree with Anonymous Referee #1 that the presentation quality needs to be improved. The authors offered extensive and interesting results (in both the main text and the supplement). However, clear and compact leading and ending sentences per paragraph are missing. This could give readers an excuse to stop reading, and thus decrease the impact of the manuscript.

The manuscript is overall excellent science. I do have some comments that the authors should address before publication.

- Throughout the manuscript, the West Pacific and the East Pacific are defined problematically. To me, the West Pacific is the side where East Asia, Southeast Asia, and Australia are, and the East Pacific is the side where North and South Americas are located. However, the authors treated them reversely (see Fig. 1a as an example). This mismatch concerns me a lot, and can cause unnecessary misunderstandings in future studies. I suggest the authors correct the two regions throughout the manuscript systematically.

- The cutoff maximum dust diameters of the seven models need to be better presented. First, the maximum diameters of the 4 modal models (in Table S. MD. 9) are missing. Second, the maximum sizes of the 3 sectional models (Table S.MD.8) do not match Page 19 lines 10-15. For example, in Table S. MD.8, the maximum diameter of CNRM-6DU is 100 μm , however, in Page 19 line 12, the maximum diameter is 50 μm . A similar issue exists in CNRM-3DU. Since maximum diameters are critical to this manuscript, I suggest the authors address these two issues, and make the maximum diameters very clear in Section 2.

- In Page 35 lines 8-10, the authors compared simulated deposition flux in Asia, and implicitly indicating that EC-Earth is better than all the other models. However, the tricky thing is that there is only one station in the Asian region (as seen in Fig. 1a). (Similarly, there is only one station in South Atlantic, South America, and Egypt). The sample number is too small to draw a significant conclusion for a continent. Thus, I

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suggest the authors make it clear that the sample number is one, and add the numbers of observational stations at all the regions in the legends of Figs. 8, 9, and 13.

- Recent progress in dust shape and its impact on dry deposition needs to be added in Page 7 lines 16-26. Jasper Kok's group has a recent paper (Huang et al., 2020) that compiled 27 measurements of realistic dust shape worldwide (including Li and Osada, 2007). They find that dust asphericity increases gravitational settling lifetime by 20% at all sizes.

- Recent progress in dust cycle needs to be added. A recent paper (Kok et al., 2020) that diagnosed the dust cycle is very similar to this manuscript, but used different models.

Minor comments:

- Typo in Page 6 line 33: correct "clay/silk" to "clay/silt"

- Typo in Table 3: the unit of grid cell area should be m² instead of kg

- Typo in Page 12 line 7: correct "19 stations" to "18 stations"

- Table 7 only offers emissions of 14 of the 16 regions. Regions "Mid-Atlantic" and "Sahel/Gulf of Guinea" are missing and should be added. Note that after adding the two regions, authors need to update the order of the top 10 regions with dust emission intensity.

- Typos exist in Table 7's order of the top 10 regions. For instance, for EC-Earth, there are two 4th largest sources (i.e., the North Sahara and the Taklamakan), which are clearly problematic. Typos also exist in models CNRM-3DU and IPSL.

References:

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