

## ***Interactive comment on “Mineral dust modelling with MADE3 in EMAC v2.54” by Christof G. Beer et al.***

### **Anonymous Referee #3**

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This manuscript, submitted to Geoscientific Model Development, presents a sensitivity study on the representation of dust emissions in the atmospheric chemistry general circulation model EMAC. The authors focus (1) on the use of dynamic dust emission instead of climatological emissions, (2) the impact of increasing vertical and horizontal resolution, and (3) the size distribution of the emitted dust.

Results show a general improvement in the representation of dust aerosols with the use of dynamic dust emissions instead of climatologies. The increased resolution is also helpful in reproducing the vertical distribution of dust aerosols, while the changes on the size distributions have less impact. All these results are interesting and provide important conclusions for model developers. The paper is generally well organized and written, but the following comments need to be taken into account before considering

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a publication in GMD.

Main comments:

- 1) The title is too general in relation to what is really dealt with in the text. I suggest to mention explicitly the word “emissions”, and possibly also a reference to the sensitivity tests (dynamic emissions, impact of resolution, size distribution).
- 2) I found that the abstract needs to be rewritten to put forward the main conclusions of the paper, and give more information on the tests realized in this study. For example, the resolutions tested here should be explicitly mentioned, and more information about the results on the size distribution could be added. Besides, the first two sentences look more like an introduction than a summary, and could therefore be deleted.
- 3) The different resolutions analyzed in this study (between 19 and 31 vertical levels, and between 1.9 and 2.8 degrees) are quite coarse compared to other climate simulations. Could you comment on this point, and argue if these results could be relevant for finer resolutions?
- 4) This paper is focusing on dust aerosols, I do not understand why you present a comparison with black carbon (BC) concentrations in Figure 6. This could confuse the purpose of the paper. I suggest to remove Figure 6 and description on BC, or at least moving it to supplementary material.

Specific comments :

- 1) Page 2 line 15: “in many GCCMs, mineral dust emissions are represented by climatologies”. I am not sure this is still true today, in particular in the recent CMIP6 simulations. Could you justify this statement with references?
- 2) Page 2 lines 31-34: The difficulty in assessing properly dust emissions (and not dust load) could be mentioned.
- 3) Page 4 line 30: Please add a reference for ERA-Interim.

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4) Page 8 Table 2: Please clarify if the total emissions are given before or after the tuning. Does "North Africa" include the Arabian desert region as mentioned in line 31 page 7?

5) Page 10 line 24: Have you tried to use another method than nearest-neighbour approach? Maybe you could interpolate the model grid on the location of the AERONET stations, which could avoid potential discontinuities between model grid boxes.

6) Page 11 Figure 3: Why have you used a log-scale for scatter plots?

7) Page 12 lines 21-25 and Figure 4: 3 stations (Ilorin, Kuwait-University and Oukaïmeden) have lower skill scores with the Tegen emissions. Could you comment on this point?

8) Section 3.2: I wonder if the resolution also improves the AOD. It would be interesting to have the skill scores on AOD for the different simulations testing the horizontal and vertical resolutions, similar as what has been done in Figure 4 for the comparison between AeroCom and Tegen emissions.

Other corrections:

1) Page 2 lines 1-2: radiative forcing (without s)

2) Page 7: there is a section 2.3.1 without 2.3.2, could you check the numbering of subsections ?

3) Figure 5 page 15: Long-dashed and short-dashed lines are difficult to distinguish. Could you improve it?

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