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Geoscientific Model Development Discussions

Interactive comment on "Revised mineral dust emissions in the atmospheric chemistry-climate model EMAC (based on MESSy 2.52)" *by* Klaus Klingmüller et al.

Anonymous Referee #1

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This paper entitled "Revised mineral dust emissions in the atmospheric chemistry-climate model EMAC (based on MESSy 2.52)" and submitted to GMD presents new developments concerning the parameterization of dust emissions in the global model ECHAM/MESSy. These new developments have been evaluated and compared to the previous version of the model in terms of the resulting aerosol optical depth. The use of ground-based (AERONET) and satellite (MODIS, IASI) has shown the improvement brought by this new version. This paper is therefore interesting for the community working on dust modeling, and the manuscript is well written. However, the current version needs major revision before considering the publication in GMD because of the following points:

- The evaluation of the revised emissions is limited to the aerosol optical depth, which is not enough to estimate the quality of the parameterization. AOD is indeed a relevant parameter to evaluate the integrated effect of dust aerosols on radiation, but it can hinder some compensating errors. Besides, such parameters as the dust size distribution, the dust vertical profile or dust deposition are essential for radiative budget and effects on climate, and are not constrained by AOD. The authors could for example add an evaluation of surface concentrations, dust deposition, dust emission fluxes or dust vertical profiles, as done by similar recent studies (Kok et al., 2014; Albani et al., 2014; Klose et al., 2014; Gherboudj et al., 2015).

- As there are many papers on dust modeling, the authors should highlight more the originality of their work. In this purpose, they should add a paragraph in the introduction presenting the state-of-the-art in dust modeling in global chemistry-climate models. This would be useful for the whole community, and would not restrain the impact of the paper to the ECHAM community as it could be the case with the current version of the paper.

Specific comments:

- Abstract: The authors mention several times the possibility to run high resolution simulations. What is the targeted resolution? Do the scheme need any modification for this high resolution?

- Page 2 Lines 18-19: The authors should justify the "rapid changes of deserts and semi-arid regions in recent decades"

- Page 3 Section 2.1: Looking at Fig.1, I get the impression that there are more regions with shrinking deserts, is it true?

- Page 3 Line 27: Any justification for the equation (1) giving the vegetation factor? Is it used in other models?

- Page 3 Lines 29-30: Could the authors clarify which statistical test they have used?

- Page 4 Section 2.3: Contrary to Sections 2.1 and 2.2, the authors have not elaborated on the differences between the two versions of the clay fraction maps. Which is the expected impact on dust emissions?

- Page 4 Lines 26-29: Is there any work forecast to include again the effect of soil moisture on dust emissions? It might be important in some regions like Sahel.

- Page 5 Line 5: This equation differs from the one given in Astitha et al. (2012), the authors should correct it or explain why it is different.

- Page 5 Line 9: The authors should justify the choice of 0.4 m/s, and clarify what they call "good results" explaining what has been compared.

- Page 5 Line 29: The parameter dmax could be added in Table 2.

- Page 6 Lines 10-15: I did not understand if finally the chemical composition of dust is included or not in the model.

- Page 6 Lines 19-21: The list of submodels is unclear for readers not familiar to the model. The authors should add a reference to have the details about these parameterizations.

- Page 6 Line 25: What is the Tanré climatology used for? (AOD or only other optical properties?)

- Page 6 Line 30: A reference to Table 1 should be added to present the simulations.

- Page 6 Line 32: Is a one-year simulation long enough to evaluate the revised dust emissions? Is there any reason to select the year 2011?

- Page 7 Line 15: Which level of AERONET AOD has been used in this comparison?

- Page 7 Line 17: Maybe the authors should divide the region B in two sub-regions, for the reader to identify more easily the different stations.

- Page 7 Lines 29-30: I don't understand how this skill score based on correlation can

be affected by a bias.

- Page 7 Section 4.1: It could be also useful to add one or two time series in stations where the score has increased.

- Page 8 Line 1: Which is the altitude of the model grid cell?

- Page 8 Line 21: Is this increase of spatial correlation statistically significant?

- Page 8 Lines 28-30: The authors could think about adding a score for the measuring the improvement in seasonal cycle, which could reinforce the robustness of their results.

- Page 9 Line 17: Same remark for the significance of the increase in the skill score.

- Page 9 Line 32: The time dependence of land cover and vegetation has not been tested here because the simulations were too short.

Technical comments:

- Page 2 Lines 8-9: The abbreviations DU_Astitha1 and DU_Astitha2 are useless since they are not used in the rest of the paper.

- Page 6 Line 24: ISORROPIA

- Figure 1: The color bar should be changed, because the values below -0.2 cannot be distinguished.

- Figure 8: The authors could replace the letters (A, B, etc.) by the name of the regions in the blue line at the top of the figure.

- Figure 9: AERONET data is represented with dots in the figure, while it is a line in the caption.

- References: The format needs to be homogenized (notably the use of first names for the first author).

References:

Albani, S., N. M. Mahowald, A. T. Perry, R. A. Scanza, C. S. Zender, N. G. Heavens, V. Maggi, J. F. Kok, and B. L. Otto-Bliesner (2014), Improved dust representation in the Community Atmosphere Model, J. Adv. Model. Earth Syst., 6, 541–570, doi:10.1002/2013MS000279.

Astitha, M., J. Lelieveld, M. Abdel Kader, A. Pozzer, and A. de Meij (2012), Parameterization of dust emissions in the global atmospheric chemistry-climate model EMAC: impact of nudging and soil properties. Atmospheric Chemistry and Physics, 12(22):11057–11083, doi:10.5194/acp-12-11057-2012.

Gherboudj, I., S. N. Beegum, B. Marticorena, and H. Ghedira (2015), Dust emission parameterization scheme over the MENA region: Sensitivity analysis to soil moisture and soil texture, J. Geophys. Res. Atmos., 120, 10,915–10,938, doi:10.1002/2015JD023338.

Klose, M., Y. Shao, X. Li, H. Zhang, M. Ishizuka, M. Mikami, and J. F. Leys (2014), Further development of a parameterization for convective turbulent dust emission and evaluation based on field observations, J. Geophys. Res. Atmos., 119, 10,441–10,457, doi:10.1002/2014JD021688.

Kok, J. F., Mahowald, N. M., Fratini, G., Gillies, J. A., Ishizuka, M., Leys, J. F., ... & Zobeck, T. M. (2014). An improved dust emission model–Part 1: Model description and comparison against measurements. Atmospheric Chemistry and Physics, 14(23), 13023-13041.

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