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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Atmospheric dust modeling from meso to global scales with the online NMMB/BSC-Dust model – Part 1: Model description, annual simulations and evaluation" *by* C. Pérez et al.

**Anonymous Referee #2**

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General comments

This paper presents the online implementation of dust emissions parameterization in the NCEP Non-Hydrostatic Multiscale Model, called NMMB/BSC-Dust model. The modules comprising/accompanying the dust emission scheme are described in detail and the evaluation section is presented in a rather clear way based on a previous work of Huneeus et al. (2010). The title of the manuscript reflects the contents of the paper and the abstract is sufficient.

In terms of scientific quality and significance, the manuscript provides a detailed description of the modelling system used to simulate and forecast the dust production in regional and global scales. The evaluation that accompanies the model description reveals the model's strengths and weaknesses which should be clearly presented in the conclusions of this paper. Modelling of desert dust in regional and global scales is a topic of continuous scientific interest because of the impacts of dust in the environment and the uncertainties that still arise from describing that procedure. This online coupled modelling system is an interesting development, mostly if the multi-scale option can benefit the process of modelling the dust intrusion in the atmosphere. The specific comments and questions that follow will help to clarify some issues that have arisen during the review process and strengthen the quality of the paper, before being accepted for publication in ACP.

Specific comments

Section 2: One of the strengths of this work would be the ability to study the dust production and distribution in both regional and global scales in an interactive way. Although the authors imply such benefit in the introduction, it is not clear if such capability exists within the NMMB model. If this modelling system can work in an interactive way between the regional and global scales (e.g. nesting option) this must be clearly stated in section 2. If not, again it must be written explicitly.

Section 2: The implementation of RRTM to treat dust as an active substance is an advantage for this modelling system. A big question arises about why the authors did not include this option in the simulations for the regional and the global scale. This should be sufficiently explained in the text.

Section 3.1.2:

a) I propose to replace the equations 4 with the ones actually used for the computation of the threshold friction velocity, plus the expression for the Reynolds number. The reference to the work of Iversen and White (1982) is sufficient for referring to the original



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equations.

b) In the discussion about the conversion of volumetric to gravimetric water content, the reference to Zender et al. (2003b) must be incorrect. It should be Zender et al. (2003a), referring to the DEAD model publication. If the authors used the same methodology as seen in that publication (equations 7-9 in Zender et al. 2003a) this should be clearly stated in the text (without the equations).

Section 3.1.3:

a) The mass fraction mi used in equation 8 probably comes from Table 1 as the notation is different (1 to 4) compared to the m1, m2, m3 shown in equation 9 (from D'Almeida (1987)). You should consider renaming the different mass fractions and add references (to Table 1 and D'Almeida) to avoid any misunderstandings.

b) Indicate the values used for the mass median diameter and geometric standard deviation in equation 10. They should be the same as in Zender et al. (2003a) but nevertheless the values must be stated in the text.

c) What value have you used for the global tuning factor C? Was it the same for the regional and the global configuration? Did you choose the value of C to match the available observations for concentration and AOD?

d) There is an inconsistency in the calculation of the vertical flux, concerning the soil size distribution. You have used the up-to-date STATSGO-FAO database for the calculation of the horizontal flux H and the sandblasting efficiency $\alpha$, but for the vertical flux F you have used the fixed background source modes from D'Almeida. Why didn't you use only STATSGO-FAO and calculate the mass overlap Mi,k using the data available on the 4 soil sizes (mass median diameter and geometric standard deviation)? In that way the emission scheme would be coherent and you would avoid this inconsistency.

Sections 4.1.1 and 4.2.1: The output from the model is calculated every 1h? Is it an average or instantaneous value? This is important for assessing the comparison with



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the observations.

Section 4.1.1: Usually the initial and boundary conditions for dust in regional modelling applications is set to zero, providing that there is no alternative solution. With the advantage of using regional and global setups within the same model it would be interesting to consider including boundary and initial conditions from the global simulation.

Section 4.2.3:

a) page 17584: The 2nd paragraph starting “The model also successfully..” should be moved to page 17585 before the paragraph “Figure 11...” to improve the consistency of the text.

b) page 17586: The model overestimates and not “underestimates” the February to April AOD in Cape Verde according to Fig.13, if the station at Cape Verde is number 24 as shown in Huneeus et al. (2010). This should be corrected in the text.

Section 5, Summary and Conclusions:

In general, the model performs reasonably well, taking into account the data availability for the evaluation and the complexity of the parametrization. What is missing from the conclusions is a comparative assessment of the two applications. For stations used in both simulations (regional and global) there should be a comment on the model’s performance concerning the consistency between the two simulations even if these refer to different years (e.g. the regional simulation for Cape Verde shows underestimation of the AOD and for the global simulation shows an overestimation for several months).

The deposition fluxes are not described very well by the model, and that can be attributed to the absence of chemistry in the model. The dust particles cannot change from the insoluble to the soluble mode which influences the ability of the particle to be deposited by wet removal processes.

The paragraph “For the regional model in North Africa...” which presents a companion paper should not be included in the conclusions section. If the authors wish to keep



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their reference to that paper, they should place it somewhere else in the text.

Technical corrections

Page 17559 Line 5: The word "..microphyisics. . ." should be corrected.

Page 17559 Line 10: "As detailed in Sect. 3.4 we have additionally coupled. . .".

Page 17559 Line 25: The reference to Zender et al. (2003b) must be Zender et al. (2003a) as this is the paper where the lognormal distribution is described. The same change must be done in page 17566, line 1.

Page 17566, line 2: The diameters in equation 10 should be written in capital letter D, to be in accordance with the rest of the text.

Page 17573, line 12: The "DQtot" must be "$\Delta$Qtot" as in equation 25.

Page 17574, line 21: "(2001) siggested. . ." must be "(2001) suggested...".

Page 17580, line 18: In the sentence "from the Sahara, and, to a minor degree, from the Anatolian plateau, Saharan, Negev deserts ..." the second reference to Sahara (the one in italics) must be removed otherwise the meaning is not clear.

Page 17583, line 1: The observation stations from the University of Miami network must be 19 and not 20. Please revise accordingly.

Caption in Fig.5 (page 17612): The last sentence has an error. It is the "..top right corner.." and not the "..top left corner..".

Caption in Fig. 11 (page 27618): In the first line of the figure caption the reference to a bottom panel must be substituted by "right panel".

Figures 5-9, 11 and 12 must be larger to be easily readable in a print out version of the manuscript. It has been hard to distinguish the details as for example the station locations during the review process.

In Figure 13, it will be much better to align the plots as they are in Fig.9, the ob-



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servations on the left and the model on the right. The consistent formats allow for comprehensible reading of the manuscript.

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