Atmos. Chem. Phys. Discuss., 15, C12068–C12070, 2016
www.atmos-chem-phys-discuss.net/15/C12068/2016/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Model development of dust emission and heterogeneous chemistry within the Community Multiscale Air Quality modeling system and its application over East Asia" *by* X. Dong et al.

Anonymous Referee #1

Received and published: 28 January 2016

The Authors presented their efforts in improving the wind-blown dust model in the Community Multiscale Air Quality (CMAQ) modeling system. These include modifying the initial threshold friction velocities, implementing source dependent speciation profiles, and including the dust related heterogeneous chemistry. The test case of March and April 2006-2010 over the East Asia was used to incrementally evaluate the new developments. The manuscript is an interesting contribution to the field in a widely used model, i.e., CMAQ, however, it has several issues in presenting the methodology and discussing the results. Therefore, I recommend the manuscript to be accepted only

if the following questions/issues are being addressed in details by the authors. There is no specific order in this list, however, I expect that the authors provide a proper response to each point.

* The main issue with the manuscript is the lack of a clear and detailed explanation of the methodology. The authors referred to the work of Tong et al. (2015) in various places in the Methodology section. This is not a published manuscript (under review in journal?) which makes it impossible for a reader to understand the details of the dust emission algorithm that the authors have used. The manuscript should be stand-alone, and the authors should explain, in details, their approach in improving the current dust model in CMAQ. Specifically, (1) It is unclear how the double-counting of the soil moisture was addressed in this study. What was the procedure for revising the original threshold velocities? It is obvious from Fig. 1(c) that the process of modifying the threshold velocities are different for different soil and land use types. What value of the soil moisture was used for each soil and land use type to modify the threshold velocities? The whole procedure needs to be presented and scientifically justified. (2) How (quantitatively) is the presence of non-erodible elements accounted for in calculating the threshold friction velocity and what value of the surface roughness was used? (3) What is the value of coefficient A (scaling factor) in Eq. (1)? (4) How is the surface roughness adjusting factor (Zi,j) calculated? (5) The new dust speciation profiles are different for Gobi and Taklamakan. How does ONE default profile in CMAQ is replaced by these TWO profiles? Does user need to pre-define the regions where each profile is being applied?

* The vertical-to-horizontal dust flux ratio in Eq. (2) is based on the linear fitting of the measurements of Gillette (1979) by Marticorena and Bergametti (1995). The authors should note that the value of K based on this equation has the unit of [1/cm], while the rest of the formulation in the manuscript is in SI units. It seems that a factor of 100 is missed in the present calculations. Also, what would be the justification of using K=0.0002 for clay%>20%? Please comment.

ACPD
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* Eq. (5) is not from Fecan et. al (1999). There is no surface roughness study in their work.

* Based on Eq. (6), the soil moisture factor is 999.9 for Sm > Wmax. I think it should be the case only when Sm > Sl. Furthermore, the third relation should be used when Wmax < Sm < Sl. Please go through the conditions in Eq. (6) and revise them. Also, how is Sl (saturation soil moisture limit) determined?

* The results deteriorate for Ca2+ when the new dust profile is used (Table 5). Please comment on the possible reasons.

A few minor corrections:

* In general, the information and texts in figures are very small and hard to read.

* Please delete the repeated word “revised” on P. 35593 line 24.

* In Eq. (3), the values of clay, silt, and sand should be in fraction not percentage.

* In Fig. (2), the orange rectangle (Fudan observation) and the purple diamond (TAQMN) are hard to find. Please consider marking them within the figure.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 35591, 2015.