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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Simulation of the mineral dust content over Western Africa with the CHIMERE-DUST model from the event to the annual scale" *by* C. Schmechtig et al.

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Reply to Reviewer 2

1/ Throughout this manuscript the comparisons between simulated and observed surface PM and AOD are defined as good or fairly good, even when these comparisons are sometimes poor. Consequently, there is no discussion in the paper about the possibility of improving the comparisons, by working on specific aspects of the model used.

Reply : Our appreciation on the level of agreement between our simulations and the observations is obviously contextual, and implicitly refer to the regional dust simulations already published in the literature. As a matter of fact, this level of agreement is

generally evaluated though visual examination of measured and simulated time series or dust load maps (typically AOD's map). So when we estimated the level of agreement as fair of good, this appreciation is relative to the results from other models, as clearly stated for the comparison at the scale of specific events. Concerning the possibility of improving the simulations, they are mentioned in different part of the manuscript when they have been identified (which is not always the case) and summarized in the conclusion. We tried to modify the manuscript by emphasising these possibilities of improvement all along the text.

2/The paper is interesting, well written and it presents a comprehensive overview of the model and its results. However, in my opinion, there is a lack of comments regarding the degree of agreement between observed and simulated variables. Thus, the validation of the model should be done. The validation of the model is necessary also because both modelled and measured data are provided without errors in the manuscript. It is consequently difficult to have an idea about the goodness of the simulation.

Reply : The errors on the AOD measurements (0.02 at the maximum) and the detection limit for the PM10 concentrations (0.6 μg.m-3) have been added in part 2.2. These values are extremely low compared to the range of AOD and PM10 concentration measured in the three stations during the dust events. The error of the model cannot be defined a priori. It is usually defined as a function of its capability to reproduce measurements, which is what we try to quantify here. Another approach is to estimate it by sensitivity analysis based for example on Monte-Carlo methods or ensemble simulations, but this would be far beyond the scope of this paper.

3/ The authors used R and NME to evaluate the model performance but without any discussion about the acceptability of the reported values for these two statistic parameters. For example, what is the acceptable range of values for NME? What are the values for R2 (not only R)?

Reply : The values of R and NME have been added as a suggestion of the editor, who encouraged us to use some of the statistical parameters used to estimate the relevance of air quality models (U.S. EPA 2007, Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze. Office of Air and adiation/Office of Air, Quality Planning and Standards, U.S. EPA, Research Triangle Park, NC). This report also gives ranges of acceptability for the different statistical indicator for air quality models. This range defines the level of reliability an air quality model must reach to be used for air quality purpose, such as the prediction of pollution events that can help decision for limitation of emissions. Dust models do not reach the same level of development than air quality models and because simulated mineral dust is much more difficult than simulating ozone or PM2.5 concentrations in urban areas The specificity and difficulties in the simulations of aerosols is clearly mentioned in the US EPA report ("it is important to understand the unique and complicated aspects of measuring and modelling particulate matter. For many reasons, PM2.5 and regional haze modelling presents many more difficulties compared to ozone modelling"). This is the reason why the US EPA standards for PM2.5 spans over a much broader range than for ozone. For dust modelling, the situation is even worse, since the simulation concerns a coarser fraction, i.e. the PM10 fraction and because the whole dust cycle is much more strongly controlled by meteorological factors. In addition, in this paper we compared the simulations with measurements in locations that are close to the dust source regions, so the simulation is very sensitive to the simulated dust emissions. So as expected, when we computed the recommended US EPA standards, we found scores that did not satisfy the "statistical acceptable range" defined for Gaseous compounds such as ozone. As an example, we found Normalized Mean Error ranging between 50 and 120% and Mean Fractional Error ranging from 82 to 104% for the surface concentrations. Regarding the EPA standard, our simulations would not be "statistically acceptable", i.e. the model would not be considered as a good prediction tool for air quality. The specificity of PM simulations leads some authors to propose adapted ranges of acceptability. We use in the revised

version the recommendations from Boyland and Russel (2007) as a reference in terms of "acceptable" range and also the statistical parameters they consider as the most relevant for PM simulations (Mean Fractional bias and error). However, we would like to stress on the fact the simulations presented here are not developed for air quality application. The purpose here is simply to evaluate how much of the dust variability can be reproduced by a simple CTM at the scale of individual dust event and at the annual scale. Considering the number of data used for the comparisons, the correlations are significant event if the level of correlation can be considered as low compared to air quality simulations. This means that the model do capture part of the dust variability and thus correctly account for the main drivers of this variability. In addition, in the present context of dust emission model, the level of agreement of our simulations cannot be properly evaluated since these parameters have never been computed for other dust models. However, we found that that it can be a starting point to promote the quantitative evaluation of regional dust models. That is why we have added some of the statistical parameters recommended by the US EPA for PM2.5 simulations and by Boylan and Russel and we now comments on their values by reference to those reported by Boyan and Russel as acceptable ranges and by .

4/ It is clearly recognized that the simulation of atmospheric PM and AOD is a very difficult task. Consequently, the authors should define as poor the correlation if necessary and if a possible explanation for the disagreement is provided.

Reply : We tried to improve this point in the manuscript. However, it is not always possible to give a single answer since the reason for discrepancies can vary for the different events.

5/ To my opinion, it would be interesting to add a short paragraph (or Supporting Information) where to provide the scatter-plots (with slopes and intercepts) relative to the comparisons between modelled and measured data reported in the Figures of the manuscript (Figures 9, 10, 11, 12, 13, 14, 16, and 17). Moreover, a Table with the values of the statistical parameters used to evaluate the degree of goodness of the

comparisons (for each scatter-plot) should be also added. The statistical parameters R and NME can be used, but also R2, Mean Bias (MB), Mean Fractional Error (MFE), Mean Normalized Gross Error (MNGE), Mean Fractional Bias (MFB), Unpaired Peak Prediction Accuracy (UPA) are useful and should be used. The range of acceptability for these statistical parameters should also be included. In such a way, a reader can get the picture of the performance of the model. At the same time the authors have the possibility of showing scatter-plots and statistical parameters for the whole year as well as for specific periods/seasons for which the comparison improves or fails compared with the mean by explaining the possible reasons for the observed differences in the text.

Reply : We added a table summarizing the values of the statistical parameter recommended by the US EPA and Boylan and Russel (2007) to estimate the performance of PM simulations. In terms of acceptability, we refer to the ranges proposed by Boylan and Russel and to the performances reached by air quality models for the simulation of PM10 and soil dust concentrations. These numbers are commented and discussed in the text at the different step of the comparison. Since the submitted paper included 18 figures, we did not want to increase this number too much. We thus only added the scatter plot of measured and simulated monthly AODs but we gives the parameters of linear regression for the hourly AOD's and for the monthly and daily concentrations. In addition, we tried to improve the text by including more discussions on the causes of the discrepancies between the simulations and the observations.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 8027, 2011.