Geoscientific

Model Development

Discussions

[GMDD]

Interactive

comment

Interactive comment on "PMCAMx-2015 evaluation over Europe against AERONET and MODIS aerosol optical depth measurements" *by* Antigoni Panagiotopoulou et al.

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(1) *The manuscript evaluates the PMCAMx model, comparing the aerosol optical depth (AOD) simulated by the model with observations from MODIS and AERONET. The manuscript fits perfectly the goals of the GMDD journal and the methodology and results are clear. However, as there are no space limitations for this journal, and being GMD(D) dedicated to technical and specific publication I would have expected to have a detail and complete description of the modeling system and the observational datasets used for the evaluation. However, to my point of view, this was not the case. Although I have no real comments on the methodology and results, the lack of detailed information raises serious doubts on the scientific relevance of such an evaluation. The*

authors should therefore add all the necessary information to the manuscript before this can be considered for publication.

We appreciate the constructive comments of the referee. We have followed the corresponding suggestions adding more information about the model and its inputs. There have been more than 10 papers that have been published describing PMCAMx and its evolution, so we necessarily rely on the corresponding references for a lot of the details. We believe that adding a complete and detailed model description (something that would require probably hundreds of pages) to every GMD paper would be clearly problematic.

Major Comments:

(2) *Aerosol concentration evaluation: The aerosol optical depth can be considered as indirect method to evaluate the model performance, as this is normally estimated from the aerosol composition and the radiative properties of the aerosol components. Therefore, I find quite disturbing the absolute lack of any discussion in the capability of the model to reproduce the observed aerosol composition and concentration before to evaluate the AODs. Wrong aerosols compositions would still give reasonable AODs, but for the wrong reasons. Therefore, I urge the authors to evaluate also their aerosol composition results. For example, in the introduction the authors stated that "these errors are probably due to an underestimation of sulfates". I expect to be enough sulfate measurements in Europe to validate this statement, as example with the AirBase dataset (http://acm.eionet.europa.eu/databases/airbase/) which present up to hourly observations for single stations. Additionally, only PM1 evaluation of PMCAMx is mentioned, although this was "limited in space" (page 4, line 15). Therefore, I would recommend to first have a through evaluation of the aerosols fields against measurements (AirBase, EMEP..) before to dig in the detail of AOD. If this was probably published elsewhere, it is impossible to find such reference in this manuscript, also in the PM-CAMx description. In the conclusions it has been mentioned that PMCAMx aerosols*

composition simulation was evaluated, but no publications have been listed.

The reviewer has unfortunately missed the following statement in lines 11-14 of page 4 of the original manuscript: "The PM$_1$ composition predictions of PMCAMx have been evaluated over Europe in May 2008 (Fountoukis et al., 2011). PMCAMx performance against airborne measurements was as good as its performance against the hourly ground measurements. More than 94 percent of the organic aerosol (OA) hourly values and more than 82 percent of the sulfate ones were reproduced within a factor of 2." This paper provides a detailed evaluation of the ability of PMCAMx to reproduce the detailed EUCAARI campaign PM composition measurements over Europe. This includes both ground measurements and airborne measurements during the EUCAARI flights. There were approximately 8500 measurements (data points) that were used in this evaluation. Please note that this is the same period as the one analyzed in the present work. We do not believe that the referee's statement about "the absolute lack of any discussion in the capability of the model to reproduce the observed aerosol composition and concentration" is justified.

In this work we exclude the periods with high dust (or in general coarse particles) concentrations, so PM$_1$ is the appropriate metric for composition evaluation. In the Fountoukis et al. (2011) paper we have used all the available PM$_1$ composition measurements in Europe for the corresponding period. This is better clarified in the revised paper.

A more detailed evaluation of the ability of PMCAMx to reproduce the organic aerosol composition during the same period has been published by Fountoukis et al. (Organic aerosol concentration and composition over Europe: insights from comparison of regional model predictions with aerosol mass spectrometer factor analysis, ACP, 9061-9076, 2014). A discussion of the findings of this evaluation exercise has been added to the revised paper.

We have added a new section in the paper focusing on just the published evaluations

of the capability of PMCAMx to reproduce the PM composition and concentration over Europe to make sure that similar misunderstandings can be avoided.

(3) *Period of simulation/analysis: The analysis is focusing on the period 1-29 May 2008. The first information on the period is on page 8, line 15, under the satellite description, which is possibly not the best location for such information. Nevertheless, it is somehow unclear to me why this period has been chosen. Why not the entire month of May? Why not another period of the 2008? Linked to this issue is also the poor description on how PMCAMx has been used to simulate the period of interest. As I am not familiar with the modeling system, it is difficult to me to understand the first sentence of page 6 "To limit the effect of the initial conditions on the results, the first six days of each simulation were excluded from the analysis". Are you referring to multiple simulations? Is the model re-initialized? Or was it a continuous simulation from which only May 2008 was extracted? These pieces of information are essential to put the model into context, but they are largely missing in the manuscript. Possibly few references would help the reader to gather the missing information, if the description of the model set-up would be too tedious. Nevertheless there are simply not there. Finally, it would have been interesting to make an analysis of an entire year, so to cover the different dynamical and chemical space, such as strong aerosol emissions in winter and strong photochemistry in summer. If that is a difficult task, at least few time-slice analysis for different seasons should be performed.*

The May 2008 period was chosen for two reasons. First this was the period of the EU-CAARI campaign focusing on a photochemically active period with summertime like concentrations. Detailed continuous measurements of PM_1 composition both at the ground and aloft as well as a corresponding emission inventory (prepared by TNO) exist for that period. The second reason was that the ability of PMCAMx to reproduce these detailed PM_1 composition measurements has already been evaluated in previous work (Fountoukis et al., 2011; 2014) and therefore we could focus on the optical properties of the fine particulate matter in this paper. The exact dates simulated were

the same as in the previous publications for consistency. We have tried to clarify the reasons for this selection in the revised paper.

We have clarified the initialization procedure of the model. Given that the initial conditions are quite uncertain and the first few days are dominated by them, we are excluding the corresponding "start-up" period from the model evaluation.

Only one baseline model simulation was performed together with a number of sensitivity tests described in the paper. The corresponding confusing sentence has been rephrased.

We do intend to extend the current work to other seasons. However, each season is characterized by its own issues. For example, during winter there is significant wood burning activity over Europe and the corresponding emissions are probably seriously underestimated in a lot of countries. We have tried to address this issue recently in Denier van der Gon et al. (ACP, 15, 6503-6519) where we try to improve the wood burning emission inventories for the wintertime. The current work focuses on a photochemically active period with the AOD dominated by mostly secondary fine aerosol.

(4) *MODIS data: The authors are using MODIS data collection 5.1. Although newer products are available since early 2015 (collection 6), it would be good to know exactly which products you are using. If I am not wrong, in the MODIS collection 5.1 in the AQUA platform both Deep-Blue and Dark-Target algorithm are available. Which one did you use? Additionally, you used "the union of Terra and Aqua MODIS AOD [...]". Could you explain what do you mean with union? How did you unify the two fields? Finally, you are using level 2 data and you calculated the monthly average for May 2008. Which spatial resolution did you use to create such field? How did you merge spatially the observations? As you were using monthly averages, why not using level 3 data? There is a severe lack of pieces of information here that are important to understand how these sensed AODs have been produced. I strongly suggest to fully rewrite the section with the additional information.*

We have followed the reviewer's suggestion and we have rewritten the corresponding section of the paper, clarifying the MODIS products used and their processing for the evaluation in an effort to avoid any ambiguities.

Briefly, regarding the details, the Dark-Target algorithm products were used. By "union" we mean that data from both Terra and Aqua datasets were used in order to have better spatial and temporal coverage. We did not alter the values of the data records and we did not apply any sort of transformations. We have changed the corresponding text to make these clear to the reader. The MODIS AOD values, retrieved with spatial resolution 10x10km^2, were collocated onto the grid of the PMCAMx modeling domain. Over the May 2008 simulation here were several values of MODIS AOD attributed to each cell of PMCAMx. Then, the monthly mean AOD for each grid cell was calculated by taking the average value of the MODIS AODs falling inside it. The L2 MODIS data are better suited to the temporal and spatial resolution of our model. Hourly PMCAMx concentration predictions were used are. Also, the filtering of the MODIS retrievals over Land and Ocean is performed prior to monthly averaging. Therefore, it is necessary to use L2 MODIS data since they have the necessary temporal resolution. In any case L3 MODIS data are derived from the L2 data.

Minor Comments:

(5) *Title: Why PMCAMx-2015? Is that a new version of PMCAMx? If so, it would be great to use the same naming convention through all the manuscript.*

We have replaced "PMCAMx-2015" with "PMCAMx" in the title and throughout the manuscript to avoid unnecessary confusion.

(6) *Page 5, line 16: The PMCAMx model is using results from WRF as meteorological forcing. Which frequency is needed? Could the author add some comments on the possible error introduced by the non exact dynamics? Is there any evaluation of the dynamics?*

We now explain that we used hourly meteorological data from WRF as input to PM-CAMx. We have also added details about the application of WRF. The performance of WRF for several air quality-relevant parameters (wind speed, wind direction, RH, temperature) in the same domain is discussed by Fountoukis et al. ACPD, 2016). The agreement with measurements was more than satisfactory.

(7) *Page 5, line 20: Same for the emissions: is there any reference and comparison with other emissions dataset?*

References for the development of the EUCAARI TNO emissions have been added.

(8) *Page 6, line 1: Would be good to mention here the period covered by the simulation(s). Here reads as there are more than one. Could the author be more specific? (see major comments).*

The first sentence in page 6 has been corrected to "To limit the effect of the initial conditions on the results, the first six days of the basecase simulation were excluded from the analysis". Only one baseline model simulation for May 2008 was performed. We have included this information in the text to make it clear to the reader.

(9) *Page 9, line 22: What do you mean with "The PMCAMx AODs have been calculated for exactly the same period as MODIS retrievals[...]?" Are you using model results at TERRA/ACQUA overpass (local time)? Are you using daily average for the periods where observations are available? Please specify.*

To evaluate PMCAMx performance for the period of May 2008 we only used model results that correspond to the same Terra/Aqua overpass time. Monthly averages are calculated from the corresponding PMCAMx AODs and the MODIS retrievals. We do not use daily average values to make the comparison more exact. We have made the proper changes to the text in order to clarify this important point.

(10) *Page 10, line 2: Does it make sense to compare this region when most of the data are masked due to the strong presence of dust aerosols there? Your data sample is strongly reduced, probably not allowing a great statistics here. The same is valid for Turkey and North Africa region.*

This is a valid concern by the reviewer. We have added this point in the revised text. Since the data sample size is small in Turkey and North Africa the corresponding comparisons provide little information. This is the reason that we have avoided discussing these regions in any detail in the paper.

(11) *Fig. 4: You mentioned that the white areas mean that not enough dust-screened AODs are present. However, it seems to me that in the Po Valley the white area is much larger that what is present in Fig. 3 form MODIS and PMCAMx. Are you sure that here you are not masking additional values?*

This was due to our choice of colors and scale. We have redrawn Figure 4 correcting this problem pointed out by the referee.

Remarks:

(12) *To my knowledge the author "Meij" should read "de Meij". Please check the references.*

We thank the reviewer for the correction. We have replaced "Meij" with "de Meij".

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