Atmospheric
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Discussions

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Interactive comment on **"Multi-model evaluation of aerosol optical properties in the AeroCom phase III Control experiment, using ground and space based columnar observations from AERONET, MODIS, AATSR and a merged satellite product as well as surface in-situ observations from GAW sites"** *by* Jonas Gliß et al.

Anonymous Referee #2

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General remarks:

The present manuscript presents the results of the annual evaluation (for the year 2010) of the aerosol optical properties of 14 global aerosol models participating in the AeroCom Phase III Control Experiment. The observational products used in this exercise include in-situ observations (AERONET and GAW) and satellite retrievals (AATR-

SU, MODIS and MERGED-FMI). It is obvious the significant effort that the authors are doing for summarising all the results. However, the large amount of results related to the assessment of the observations and the ensemble and individual model evaluation results makes it difficult to follow all the discussions.

While the results of the study are interesting to be published, their presentation and discussion are not yet sufficient enough to be published at Atmospheric Chemistry and Physics in the current form. Consider being publishing after addressing revisions which are explained below.

General comments:

As a general comment, I would like to emphasise the effort of the authors for synthesizing all the information in this manuscript. However, a large number of figures, tables and supplementary material can introduce some confusion to the reader. You refer Tables and Figures that at the same time refer other Tables and Figures from the Appendix (see, for example, Table 3).

Also, it is hard to can get clear conclusions of the comparison because of the mixture of different models and variables. I mean the use of some models for the analysis of the representativity (Section 2.4) are not considered in the AeroCom ensemble (see Table A1) or some models that are providing AOD and others, AODclear-sky for the comparison. As it is shown in Table A1, there are some models (as INCA and ECMWF-IFS) are not considered in the AeroCom ensemble. Is there any advantage to keeping some models outside the AeroCom ensemble?

Is there any reason for selecting the year 2010 for the comparison? Maybe, the observation's availability or the emissions considered in the modelling simulations? You should include some words in the manuscript.

It is value the effort that the authors include for the assessment and representativity of the different observational datasets used in the comparison. As it is indicated in

Table 1, authors are considering different time-frequency for the various databases. I understand that all the observational datasets are converted to monthly averages for the comparison with the monthly averages of the model. Could you include information about the delivered output frequency of the model?

Moreover, you mention that you are computing the AeroCom mean and median at 2° x 3° and use the raw resolution of the rest of the models for the AERONET and GAW comparison. Meanwhile, you regrid all the models to 5° x 5° for the satellite comparison that also you compare with AERONET. Are there the results of AeroCom mean/median consistent in both comparisons?

Also, the observational aerosol products that you are considering are only available during the daytime, can you quantify this uncertainty? Figures A3-A5 should support this discussion because you are comparing the impact of considering 3hourly (Figure A3) and hourly (Figure A4) basis vs monthly, which is 14% and 8% respectively. However, it is difficult to understand the impact when you are comparing different models and different variables.

From the satellite comparison, you are considering for different datasets MODIS-Aqua, MODIS-Terra, AATSR-SU and MERGE-FMI, is there is a recommendation that you can provide in the manuscript about the most reliable for model evaluation purposes?

To help the reader, I would move the results of the individual models (Sect. 4) to a Supplement. I would keep the most important findings related to the multi-model comparison in the main discussion. Considering that you are including different models, it would be expected to find more discussion about possible improvements to have into consideration for the model community as aerosol emissions, size distribution, hygroscopicity or aerosol optical properties used.

In Section 5, it is where you introduce the results considering AOD clear-sky from model experiments. Is there any difference in the comparison with satellites between those models that delivered AOD or AODclear-sky? Finally, please, revise the refer-

ences to figures, tables and sections there is a mixture of formats.

Minor comments:

Page 2 Line 16: Capital letters in Aqua and Terra, i.e., MODIS-Aqua and MODIS-Terra.

Page 2 Line 21: Capital letters in Terra, i.e., MODIS-Terra.

Page 3 Lines 51-55: Add a reference as Boucher, O., Randall, D., Artaxo, P., Bretherton, C., Feingold, G., Forster, P., ... & Rasch, P. (2013). Clouds and aerosols. In Climate change 2013: the physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 571-657). Cambridge University Press.

Page 3 Lines 58-59: Add a reference.

Page 3 Lines 64-65: Add a reference related to the quantification of DMS.

Page 4 Line 83: Introduce the GAW acronym.

Page 4 Line 102: What are the advances between the set of models used in Kinne et al. (2006) and the ones considered in the present study? Is there any common/different feature between both studies? Is there any major improvement in the optical properties calculation from the modelling side?

Page 4 Line 103: Remove "aerosol optical depth", it is already introduced.

Page 5 Line 121: Introduce MEC and OD.

Page 5 Line 137: In Figure 1 in the AATS-SU AE map, it is observed fine aerosols (high AE values, > 1) in Antarctica, could you add a comment on it?

Page 6 Section 2.1.1: Consider to mention that AERONET SDA products (AOD coarse and AOD fine) are provided at 500nm. Also, you should include the number of sites used for the comparison in Table 1 and do reference to the location in Figure 1, for example.

Page 6 Line 163: Introduce STP.

Pages 6-7 Section 2.2.2: You should include the number of the final selection of sites used for the comparison shown in Table 1, instead of mentioning the ones excluded and do reference of the location in Figure 1, for example.

Page 8 Lines 216: What Level are you considering in the study? I suppose that it is Level 3, but it is better to mention again here.

Page 8 Section 2.1.5: It should be mentioned that MODIS and AATS products are considered inside this MERGED-FMI.

Page 8 Line 234: Table is in capital letters.

Page 9 Line 255: Indicates that this is Appendix C

Page 9 Line 265: Specify the reference to cf. 1.

Page 10 Lines 296-298: In Section 2.4, for the representativity of the results you are combining different models and observational datasets for concluding that "the overall difference is of the order of 10% and 0.2 for NMB and correlation, respectively". This is supposed shown in Table 3, but the numbers are not coincident.

Page 11 Section 2.5: Because you mention the bias to Europe and North America because of the density of sites. Is there any regional results in the comparison satellite vs AERONET that you can consider to include?

Page 12 Line 341: Add Figure 3.

Page 13 Line 370: Missing ".".

Page 13 Line 379: Extra space.

Table 2: Add a reference to the supplementary material (the excel table).

Figure 2: Replace the continuous colour palettes for a new one with categories as in Figure 1. It is easier for the reader to associate each colour to the corresponding

category.

Figures 4-8: Add the corresponding legend associated with the colours. Another possibility is to keep the numbers and use the colour scale to indicate what models are above/under the AeroCom median/mean which is the reference.

Figures 10-12: Replace the continuous colour palettes for a new one with categories as in Figure 9. It is easier for the reader to associate each colour to the corresponding category.

Figures A1 and A2: The sites in the heatmap are organised by alphabetical order, to can distinguish a pattern, maybe it would be better to create clusters per continent, latitude, longitude. Replace the continuous colour palettes for a new one with categories as in Figure 9. It is easier for the reader to associate each colour to the corresponding category.