

# ***Interactive comment on “An assessment of aerosol optical properties from remote sensing observations and regional chemistry-climate coupled models over Europe” by Laura Palacios-Peña et al.***

## **Anonymous Referee #2**

Received and published: 31 October 2017

General comments: The manuscript “An assessment of aerosol optical properties from remote sensing observations and regional chemistry-climate coupled models over Europe” presents: a) An intercomparison of Aerosol Optical Depth (AOD) from distinct remote sensing platforms (ground-based and orbital) in order to identify the more accurate AOD product. Ground-based AOD retrieval from AERONET is taken as the reference to validate the remain (orbital) products.

b) Once defined the best satellite AOD products, the authors applied them, along AERONET retrieval, in the evaluation of a set of Chemistry transport models (CTMs)

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simulation of Aerosol Optical Depth (AOD) and Angstrom Exponent (AE) for two aerosol events that affected Europe. One related to an episode of biomass burning in Russia and another to a Saharan dust-outbreak event. The sensitivity of the simulation of AOD and AE by distinct modelling systems to the inclusion of aerosol radiative interaction (ARI) and Aerosol Cloud Interaction(ACI) is evaluated.

The manuscript is within the scope of ACP, the issue discussed is an important topic in the field of atmospheric and climate science. The goal and the methods are clearly described, and the results has potential to contribute to the understanding and improvement of aerosol modelling capabilities over Europe. However, the paper needs some work before its publication. The discussion of the results of the study may be conducted in more concise way in order to make clearer the paper main results and it easier to the reader. Moreover, an effort to go beyond simple descriptions of what figures are showing, i.e. into a further discussion on influence of the accuracy of the representation and mechanism of aerosol effects the models analysed. I think would bring significant contribution. I would say a similar comment regarding satellite products evaluation, few is discussed regarding the essential drivers of the difference between the products investigated. I highlight these aspects taking as reference one of the goal of the manuscript, which is "...to characterize the uncertainties associated with satellite and modelling...".

Specific comments: Page 1, Line 13: "The evaluated variables were aerosol optical depth(AOD) and Angstrom Exponent (AE)..." I think it would be helpful to provide this information early in the abstract text.

Page 4, Line 9: "However, none of the aforementioned studies has evaluated the representation of aerosol optical properties and the effects of ARI+ACI on these properties." At this stage, I would suggest a short descriptive exercise on the ways through(mechanisms) which ARI and ACI can influence the simulation of AOD and AE in order to establish a theoretical reference to help the contextualization of the paper main results. For example, which impact one would expect to see on the AOD field just by adding ARI, would inclusion of ACI reinforce or counter balance ARI impact? In

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other words, a short revision about what have been observed in previous study regarding the exact feedback effects that the current manuscript aims to evaluate.

Page 7, Line 12: “-0.02-10%, +0.04+10%” to “-0.02-10%\*AOD, +0.04+10%\*AOD”. Somewhere else in the text there is a similar correction needed.

Page 8, Line 8 and 9: Define the variable correspondent to each equation (for example, NI\_MAE= eq. 1)

Page 8, Line 18: “as data were not available”. Which AE data is not available, from satellite or from AERONET? Clarify.

Page 8, Line 17: “Table 2” – It is not clear which AERONET wavelength the authors are comparing with the satellite wavelength, since in the manuscript is suggested 670 nm as the reference wavelength for AERONET. However, for the satellite a set of different wavelengths are presented. Similar issue occurs for Figure A1, there is no indication of wavelength in the axes, AOD at which wavelength the authors are comparing? That have to be made clear in the plots. I would extend my comments to the captions of both table and figure, needed to be auto-explicative, and it is not.

Page 9, Line 23: “Figures 2 shows the evaluation of AOD. . .”. I would suggest the authors to think about the arrangement of the elements of Figure 2, mainly regarding the distribution of the AOD field (a). Moreover, I wonder why the authors did not considered the similar colour scale for satellite and model field, that would help.

Page 10, Line 32: “. . . the best skills was the Toravere station. . .”. I consider important to show in the map the locations of the stations that the manuscript highlight as is done for Toravere, so one can have a better idea where the mode is performing better.

Page 11, Line 9 – 12: “ However, our results. . .”. I wonder about the role of emissions and meteorology (circulation/precipitation etc.) on the discrepancy between observation and models, since in the manuscript few is said on this respect. I’m a bit confuse, according to Figure A1, satellite(MODIS) seems to underestimate AOD when com-

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pared with AERONET, at least for Russian fire. Figure 3 shows that models overestimate AOD when compared with AERONET, and Figure 2 that models underestimate AOD regarding satellite. If in general models AOD is higher than AERONET and lower than satellite, how can AERONET be higher than satellite? May I have understood it wrong, but I could not figure it out.

Page 12, Line 4: “. . .with available AE data was very limited and substantially lower than for AOD.” AERONET AE used to be in same frequency that AOD, is not that the case for your stations?

Page 12, Line 10: “3.2.2 Saharan desert dust outbreak case”. I’m a bit concerned about this case, since the satellites and AERONET barely spotted this event over Europe, which clearly reflected in the amount of observational data to conduct a consistent analysis of the models simulations performance. An example, the highlighted AERONET station in Figure 7.

Page 12, Line 17: “This value was not very high for a dust outbreak, but was caused by wet deposition(rain during the episode. . .”. This is what I was referring when claiming previously to the potential influence of meteorology on the models performance against observations, and that I think should be considered in the analysis.

Page 15, Lin 8-10: This seems to be a challenge for the manuscript discussion as whole, i.e, the separation of the impact of the issue of aerosol accurate model representation (emission/microphysics) from the impact of neglecting aerosol effects (ARI+ACI). Another point is, I recognize that ensemble may be the best options to provide a prognostic or diagnostic of an atmospheric event when one has a set of numerical simulations from distinct models. However, when the focused is to assess the effect of particular feedback mechanism, which seems to be the case, analysis should be shifted to individual model response. There are some individual analysis across the manuscript, but I think there is a particular emphasis in the ensemble results.

Technical corrections:

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It seems that there is an excessive use of bracket across the text, the authors may re-evaluate when it is necessary to use this resource.

In general, most of captions of Figures and Tables need more details description.

Page 1, Line 2: "...uncertain forcing agents..." to "... uncertain climate forcing agents ..."

Page 1, Line 5: "... inclusion of aerosol-radiation (ARI) or aerosol-cloud interactions (ACI) helps improve..." to "... inclusion of aerosol-radiation (ARI) or/and aerosol-cloud interactions (ACI) helps to improve..."

Page 1, Line 8: "... Mediterranean Sea..." to "... the Mediterranean Sea..."

Page 2, Line 21: "The main advantages of remote sensing are: (1) they do not perturb the observed..." to "The main advantages of remote sensing are: (1) it do not perturb the observed..."

Page 2, Line 32: "There are instruments with onboard satellites..." to "There are instruments aboard satellites..."

Page 3, Line 8: "...different instruments of onboard satellites..." to "...different instruments aboard of satellites..."

Page 4, Line 8-9: "...studies has evaluated..." to "...studies have evaluated..."

Page 6, Line 24: "...Forkel et al(2015), Im et al..." to "...Forkel et al(2015) and Im et al..."

Page 6, Line 25: "...Chapman et al (2009), Barnard et al..." to "...Chapman et al (2009) and Barnard et al..."

Page 7, Line 4: "...on board a satellites..." to "...aboard satellites,..."

Page 11, Line 5: "...as indicated Palacios-Penã..." to "...as indicated in Palacios-Penã..."

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Page 13, Line 6: "...at the PM10 levels..." to "...of the PM10 levels..."

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