

***Interactive comment on “Investigating the quality of modeled aerosol profiles based on combined lidar and sunphotometer data” by Nikolaos Siomos et al.***

**Anonymous Referee #3**

Received and published: 13 February 2017

The study presents an evaluation of CAMx model against LIRIC output profiles retrieved above the city of Thessaloniki. It is an interesting study with valuable results for the scientific community. However, the authors need to address some issues before publication. As it is currently presented, the idea of the validation is sometimes lost along the manuscript and the paper becomes a little too descriptive. The manuscript would benefit from a more in-depth discussion regarding the validation and more discussion including uncertainties is definitely needed. A review of the writing, which is sometimes confusing, and a possible shortening in length would also be useful to improve the manuscript. Find some more detailed comments below:

Page 1

C1

Line 7: A fractional bias of 24.8% does not seem “close”. I suggest you use the absolute value here instead of percentage.

Page 2

Line 3: Rephrase this sentence. As it is written, it looks like EMEP is a model instead of a programme.

Lines 27-35: The identification of PM<sub>2.5</sub> and PM<sub>10</sub> particles with the fine mode and the coarse mode from LIRIC is not completely accurate. Please, rewrite.

Page 3

Lines 1-9: This information seems more appropriate for the methodology section than for the introduction.

Line 25: “pre-processing”

Line 27: Parenthesis are missing for the reference Schneider et al. (2000). Please, also add the more recent reference Pappalardo et al. (2014)

Line 31: Was the sun photometer deployed at Thessaloniki just for this study?

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Line 21: Please, rewrite. It is not clear what you mean by “user defined uncertainties”. Does the study by Filioglou et al. (2016) take into the account the uncertainties in the input lidar and radiometer data or just the user defined input parameters? In that case, what is the estimated uncertainty of the output profiles? Include also here that LIRIC has been validated against in-situ aircraft measurements to emphasize that it can be used as an independent reliable tool for the validation of CAMx (see e.g. Granados-Munoz et al., 2016 and Kokkalis et al., 2017)

line 29: What do you mean by characterization procedure of the lidar profiles?

Page 7

C2

Line 20: How did you calculate the full overlap height? Add references here and/or provide more details.

Line 26: Be more specific for the maximum height, what it is consider a significant quantity?

Line 27: Replace summing by adding

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Line 5: Why are you using 1.5 and 2.6 g\*cm<sup>-3</sup> ? Why don't you use the known aerosol densities provided by CAMx for each case? That would lead to a more accurate comparison between LIRIC and CAMx.

Lines 8-14: Since CAMx lacks of biomass burning aerosol emissions and does not consider desert dust emissions directly, I understand that the fires and dust categories are only used to evaluate the impact that this cases have on the model performance. However, for the evaluation purpose it would make more sense to me to include a category excluding biomass burning and dust cases. That way you would be comparing apples to apples.

Line 21: Please, specify the criteria you use to detect dust cases. Some trajectories do not seem to originate in dust source regions in Figure 1. Idem for continental.

Line 33: This sentence is confusing. Rewrite. What is the diameter for separation between fine and mode in CAMx? Is it the same as in LIRIC?

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Line 1: Specify here the number of cases for the comparison. Why does this number emphasize the need of statistics?

Lines 11-12: Provide more updated references.

Line 15: Is this identification criteria based on a sensitivity analysis, previous studies,

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etc? Please, explain.

Line 17: What it is the advantage of applying the WCT to LIRIC output profiles instead of the range-corrected signal as in previous studies? Do you obtain similar results using the volume concentration profiles and the RCS?

Line 23: No aerosol is expected above the upper limit in LIRIC, why don't you set these values to zero instead of a constant value?

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Line 17: More discussion, including numerical values, is missing here. For the case on January 13, 2014, it looks like most of the aerosol concentration is below the full overlap height. How does this affect the output profiles? How reliable are LIRIC output profiles in this case? Please, add some discussion in this respect.

Lines 19-26: As it is presented, it is not very clear what the contribution of the analysis of the optical properties to the evaluation is. Considering that the goal of the paper is the evaluation of CAMx, I think this section should be shorter or rewritten to clarify its purpose. Additionally, previous studies have shown that backscatter provided by LIRIC is affected by large uncertainties, especially for non-spherical particles (see Wagner et al., 2013 or Granados-Munoz et al., 2014). How do these backscatter profiles compared to those retrieved with a different method ( e.g. Klett-Fernald)?

Line 20: specify if it's extinction or backscatter related Angstrom exponent.

Line 20: It should be figure 2e instead of figure 2d. Include also the CAMx profile in Figure 2f

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Lines 10-15: Add numerical values in the discussion. In general in this section 4.1, add more discussion taking into account the uncertainties and shortcomings in LIRIC (and the model if provided by the modellers).

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Line 24: Can you provide some information about the boundary layer height values obtained in the study? Besides, because of the incomplete overlap, LIRIC uncertainty in the PBL should be higher than in the troposphere. Take it into account when discussing the results.

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Line 7: “are presented”

Page 15

Line 2: Provide more details on the results obtained removing the dust cases

Line 7: Do you have information about the relative humidity above Thessaloniki during the study period? This could give an idea about how important the hygroscopic growth is and how much it could affect the comparison.

Consider rewriting the conclusions section after all previous comments.

Table 2: Should be  $a$  instead of  $z$  (or vice-versa)?

Figure 3: Add also the number of cases for the no fires category in the figure

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