

## ***Interactive comment on “Profiling of fine- and coarse-mode particles with LIRIC (Lidar/Radiometer Inversion Code)” by M. R. Perrone et al.***

**M. R. Perrone et al.**

perrone@le.infn.it

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Dear Referee #1, many thanks for your comments which have allowed improving the paper. Answers and/or notes to your comments are reported below. A marked copy of the paper where all changes are highlighted has also been posted as supplement.

1. Authors assume constant lidar ratio when calculate extinction coefficient with CII approach, which is the source of possible errors. No sensitivity studies allowing realistically estimate these errors are presented.

A sensitivity test on the impact of an altitude dependent LR on the CII procedure results

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is provided in Section 4.1.1 of the paper by Perrone et al. 2014. In that paper it is shown that the uncertainties on the assumption of a height independent LR, may be comparable to the ones associated with the “choice” of an height dependent LR. However, to better address the problem the following sentence has been added on pag. 9, line 11 of the revised manuscript:

“The LR constrain may represent a weak point of the CII procedure. A sensitivity test on the impact of an altitude dependent LR on the CII procedure results is provided in Perrone et al. 2014.”

2. LIRIC code assumes that the fine and the coarse mode radii are height independent. Such assumption may lead to the errors in the retrieved profiles of volume concentration. Corresponding sensitivity studies are not presented.

The LIRIC tool at present does not allow to vary fine and coarse mode radii with the altitude. This problem will be afforded in the future. Therefore, the main goal of the paper was to compare LIRIC results with the corresponding ones from the CII-graphical framework scheme in order to highlight possible problems linked to the LIRIC constrain that fine and coarse mode radii are altitude independent.

3. Authors provide uncertainty of extinction calculation (and particle volume retrieval as well) as standard deviation from mean value, which is not correct. The uncertainty of retrieval and deviation from obtained mean value is not the same.

To take into account your comment, the sentence on page 7 line 12 of the revised manuscript:

“...to calculate the mean fine  $C_{f,a}(\lambda_i, z)$  and coarse  $C_{c,a}(\lambda_i, z)$  particle volume concentration profiles. The  $C_{f,a}(\lambda_i, z)$  and  $C_{c,a}(\lambda_i, z)$  uncertainties have been set equal to  $\pm 1$  standard deviation (SD) of the corresponding mean value.”

has been replaced with following one:

“...to calculate the mean fine  $C_{f,a}(\lambda_i, z)$  and coarse  $C_{c,a}(\lambda_i, z)$  particle volume con-

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centrations with corresponding standard deviations (SDs) of the mean value.”

In addition, the sentence on page 7 line 23 of the revised manuscript:

“For each set of lidar data, the mean extinction and backscatter profile is calculated by averaging all  $\alpha_L(\lambda_i, z)$  and  $\beta_L(\lambda_i, z)$  profiles, respectively determined by the LIRIC outputs satisfying condition (1).  $\alpha_L(\lambda_i, z)$  and  $\beta_L(\lambda_i, z)$  uncertainties are set equal to  $\pm 1$  SD of the corresponding mean value.”

has been replaced with the following one:

“For each set of lidar data, mean extinction and backscatter coefficients with corresponding SDs are calculated by averaging all  $\alpha_L(\lambda_i, z)$  and  $\beta_L(\lambda_i, z)$  profiles, respectively determined by the LIRIC outputs satisfying condition (1).”

4. Because of possible biases in extinction calculation the presented graphical aerosol classification framework may be characterized by high uncertainty so it can't be used for verification of LIRIC retrieval. Neither of these techniques can be considered as etalon, hence we can talk only about comparison.

We believe that the satisfactory accordance of the CII procedure–graphical framework results with the corresponding columnar data from AERONET (mainly discussed in Perrone et al., 2014) shows that the methodology is reliable. In addition, the satisfactory accordance of LIRIC results with the corresponding ones retrieved from the CII procedure-graphical method on 12 September, 2011 (Figs. 6, 7, and 9 of the paper), shows that the results from the two methodologies are quite similar mainly when aerosol properties vary weakly with the altitude. As a consequence, the results of both methodologies can be compared. However, each methodology has its advantages and limits and cannot be considered as an etalon as you mentioned.

5. Authors retrieve vertical variation of the fine mode radius assuming that lidar ratio doesn't change. I think this way they put restriction on the class of considered solutions.

Yes, as we have outlined in the paper the altitude independent LR constrain limits  
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the solutions. But, we believe that the choice of a height-constant LR may lead to fewer uncertainties than the ones that can be associated to a “personal choice” of a height-dependent LR, likely based on backtrajectories and/or depolarization data. In any case, LIRIC and the CII procedure should be used when elastic lidar signals at 3 wavelengths are only available. Note that many multi wavelength lidar systems can provide only elastic lidar signals in daytime operation.

Specific comments

Abstract is too long, looks more like Conclusion.

The abstract has been shortened.

p.3, ln21 "Aerosol effects on climate depend on the vertical distribution of the aerosol optical and microphysical properties (e.g. Perrone et al., 2012)." This problem is discussed for the long time, earlier references are needed.

The book by Seinfeld and Pandis (1998) has been added as additional reference.

p.13, ln.6. "...since the efficiency of scattering by small particles is more pronounced at the short wavelengths (Lopatin et al., 2013)..." The reference for earlier classical work should be given

The paper by O'Neill et al. (2003) has been added as additional reference.

p.16, ln 9. " the particle fine modal radius varies with z spanning the  $\sim 0.02$ - $0.17 \mu\text{m}$  range" How can authors distinguish  $0.02 \mu\text{m}$  radius when shortest wavelength is  $355 \text{ nm}$ ?

The sentence “It is interesting to observe: 1) that the  $\Delta \hat{A}(z)$  vs  $\hat{A}(355, 1064, z)$  mean values are on the graphical framework area delimited by  $\hat{A}_{\text{GF}}$  values spanning the 70%-99% range, in satisfactory accordance with LIRIC results, and 2) that the particle fine modal radius varies with z spanning the  $\sim 0.02$ - $0.17 \mu\text{m}$  range, in contrast to LIRIC results (triangle).”

has been replaced with the following:

“It is interesting to observe that the  $\Delta\hat{A}(z)$  vs  $\hat{A}(355,1064, z)$  mean values are on the graphical framework area delimited by  $\hat{A}_{GF}$  values spanning the 70%-99% range, in satisfactory accordance with LIRIC results, and  $R_{f,GF}$  values spanning the  $\sim 0.02$ - $0.17 \mu\text{m}$  range, in contrast to LIRIC results (triangle).”

p.16, ln.11 " CII-procedure does not make any constrain on the dependence on altitude of the particle size". Isn't constant lidar ratio a constraint?

The sentences “Note that the CII-procedure does not make any constrain on the dependence on altitude of the particle size. The selection of a height-independent LR to match the AOT represents the main source of uncertainties of the CII-procedure, according to Perrone et al. (2014).”

have been replaced with the following:

“Note that the selection of a height-independent LR to match the AOT represents the main source of uncertainties of the CII-procedure, according to Perrone et al. (2014).

Fig.1 "...the coarse modal radius equal to 0.75, 0.9, 0.105, and 0.12m..." It is misprint

O.K. done

Please also note the supplement to this comment:

<http://www.atmos-meas-tech-discuss.net/7/C3098/2014/amtd-7-C3098-2014-supplement.pdf>

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Interactive comment on Atmos. Meas. Tech. Discuss., 7, 8881, 2014.