

## ***Interactive comment on “Assessment of vertically-resolved PM<sub>10</sub> from mobile lidar observations” by J.-C. Raut and P. Chazette***

### **Anonymous Referee #2**

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#### General Comments

This paper describes a technique for using mobile lidar measurements to derive PM<sub>10</sub> concentrations, and describes how such concentrations were derived in and around Paris, France. The paper describes the mobile lidar system which was driven around the Paris area and was able to make backscattering measurements while moving between various sites. Measurements of particle size, composition, scattering, and PM<sub>10</sub> from surface based in situ measurements were used to derive relationships between the lidar derived aerosol extinction values and PM<sub>10</sub>. These relationships were then used to derive PM<sub>10</sub> concentrations as a function of altitude in and around Paris.

The paper provides a reasonable description of the technique and the results. However, there are a number of areas that were not clear and require further explanation

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and clarification.

Major comments:

Surface measurements of aerosol composition, scattering, and PM10 are used to derive relationships between the aerosol extinction (355 nm) derived from the lidar observations and PM10. These relationships are derived at various locations (urban, suburban, rural) near Paris based on the surface and lidar measurements. As shown in Table 1, there are significant differences in these relationships ( $k$  values) between these locations.

What are the variability and uncertainty in these parameters at these given locations? The method seems to assume that the  $k_1$  or  $k_2$  value at a particular location is always used at this location to convert aerosol extinction into PM10. . .is this correct? (Urban aerosol value for aerosol in boundary layer or nocturnal boundary layer, periurban value for aerosols in residual layer, etc.) This assumes they these specific aerosol types with these specific values are always at these locations and altitudes; what is the uncertainty in this assumption? Especially for aerosols above the surface, there is no way using the lidar data alone to be sure that the assumed aerosol type is what was actually present. Therefore, there must be some uncertainty in the retrieved PM10 concentration due to the uncertainty in the assumed aerosol type. What is the implication of this uncertainty on the derived PM10 concentrations?

Figures 3-8 show PM10 concentrations as a function of location and altitude based on the lidar measurements. Do each of these figures use a specific  $k$  value throughout the image or do the  $k$  values vary as a function of location in each image? If the  $k$  values vary from the urban to periurban in each image, how do they vary? For example, at the surface, does the  $k$  value vary linearly from urban to periurban as a function of distance as the lidar traveled from the urban location to the periurban location? Does this variation vary with altitude?

There were a number of assumptions that were made in this paper to carry out these

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analyses. The paper should provide more discussion of how the uncertainties associated with these assumptions impact the retrievals of PM<sub>10</sub> profiles using the lidar data.

There are numerous locations in the paper where grammatical corrections and clarifications are required. The correction of these errors is beyond the scope of this review, which has focused on the measurements and analyses. Therefore, the authors should identify someone proficient in English to improve improve the wording and make the necessary technical changes to the paper.

Other Comments:

1. (abstract, line 15) Does this standard deviation refer to an root-mean-square (rms) difference or a bias difference?
2. (page 13476, line 25) Please provide a reference for the statement that anthropogenic aerosols account for 10
3. (Section 2.1) This discussion assumes that the aerosol properties, and their horizontal distribution over this region, were constant over this period (1999-2007). Can the authors provide measurements or analyses to support this assumption?
4. (Section 2.2) What is the frequency of measurements by the various measurement systems (lidar, nephelometer, TEOM, etc.)?
5. (page 13480, line 10) How was the nephelometer calibrated?
6. (page 13482, line 25) If the point was to use the nephelometer measurements at the surface to derive aerosol extinction at 355 nm, similar to the lidar, why not use the nephelometer measurements at 450 nm instead of at 700 nm? This would reduce uncertainties associated with using the Angstrom exponent to convert a measurement at a longer wavelength to the shorter wavelength at 355 nm.
7. (page 13483, equation 2) This equation assumes that the Angstrom exponent be-

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tween 355 and 450 nm is the same between 450 and 700 nm. This is not necessarily true. There should be some discussion of this Angstrom exponent, its uncertainties, and how these uncertainties impact the retrieved extinction at 355 nm.

8. (page 13483, line 3) At the rural site, and at low RH, the particles may be nonspherical. How does the use of Mie calculations, which assumes spherical aerosols, impact the uncertainties of the derived single scattering albedo?

9. (page 13487 and 13491, description of relative humidity correction) This section appears to describe how the lidar measurements of aerosol extinction are adjusted for hygroscopic growth due to high relative humidity in order to obtain the values of dry aerosol extinction to convert to PM<sub>10</sub>. Is this in fact what is done? If so, how is the profile of relative humidity known in order to apply this correction throughout the lidar profile?

10. (page 13487 and 13491, description of relative humidity correction) Is the humidification factor measured at the surface assumed to be constant with altitude?

11. (page 13487, description of Figure 2) It would be useful if slopes and correlation coefficients were added to these figures; the text indicates that the correlation varies, but there is no quantitative information provided on how much this correlation changed.

12. (page 13490, line 3) Why was the uncertainty on PM<sub>10</sub> larger in the rural location?

13. (page 13490, line 17) Is the 5

14. (page 13491, line 11) The sentence should be reworded to say that the retrieved extinction coefficients were adjusted (not corrected) for hygroscopic growth. Also, how large were these adjustments? 10

15. (page 13491, line 20) What is the minimum and maximum thickness of these elevated layers that were detected from the lidar measurements?

16. (page 13492, line 20) The text currently says that the altitude of the residual layer

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was higher due to higher temperatures on May 23. Are there not other possible explanations? Would not weaker larger scale subsidence also have led to a higher residual layer?

17. (page 13493, line 13) In the discussion of Figure 6, it would be helpful if this Figure had some annotation added to indicate the change in concentration between the two locations described in this paragraph.

18. (page 13493, line 19) At what altitude is the plume aloft?

19. (page 13494, line 10) Is this total depolarization, or aerosol (particulate) depolarization?

20. (page 13494, line 25) How do you know that dust was actually over the Atlantic Ocean and so could have been transported by these backtrajectories?

21. (page 13495, line 5) How was the value of  $BER=0.020 \text{ sr}^{-1}$  in the dust layer chosen? Please provide references.

22. (section 6) The RMSE between the lowest lidar observations at 200 m and the surface was found to be half the concentrations in the Paris area. This is a large difference. The text seems to say that this represents good agreement given that there can be large differences in PM10 between the surface and 200 m. Perhaps this may be so, but such a single comparison should not represent an evaluation of the technique. It would be much more useful to show a time series of points at the surface and at 200 m rather than a single comparison. Although such a comparison would not represent a validation of the technique, it would provide an indication of possible variations below 200 m and give an indication of how representative the surface measurements are of values aloft. One possible way of doing this would be to extend the plots shown in Figures 3b-8b down to the surface (instead of 200 m), and indicate the surface concentrations with points color coded to match the legend used for the PM10 concentrations derived from the lidar measurements.

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23. (Table 1) The caption for this figure should identify what each of these columns represent.

24. (Table 3) It would be useful if the altitudes and thicknesses of these layers were also specified.

25. (Figure 9a) What do the white lines represent? How were they determined?

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