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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Assessment of vertically-resolved PM_{10} from mobile lidar observations" *by* J.-C. Raut and P. Chazette

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Response to reviewer1

The authors appreciated the comments of reviewer1 that help to improve our manuscript. Please find a point-by-point discussion and answer of the issues raised by the reviewer. To facilitate the work for the reviewers and readers, the reviewer s comments and suggestions are preceding each reply in bold face.

The ground sites shown in the top panels of Figures 3-8 require further description. Are these sites directly influenced by traffic or industrial pollution, or are they more representative of Paris background? This may also help to explain

some of the discrepancy between lidar-based PM10 and surface measurements.

Most of the ground sites, where continuous measurements are performed, are considered as "urban stations", indicating that they are mostly representative of Paris background. Only three stations (Bd. Auteuil, Pl. Victor Basch and Champs-Elysées) turn out to be traffic stations. It is worth noting that lidar-derived mass concentrations generally overestimate PM10 values reported on Paris background stations, but underestimate measurements obtained in traffic stations. This can be explain by the fact that lidar measurements are performed over Paris highways and in traffic conditions but, due to the overlap factor, only values above 200 m are given in this study. At this altitude, pollutants have had time to be slightly diluted along the vertical and their concentrations have therefore decreased. This discussion has been added in Sect. 6.

p. 13476 - line 24-25 - A citation should be given for the 10% given here. Also, the authors need to mention the high degree of regional variation associated with this number.

The following sentence has been added: The anthropogenic aerosols currently account for about 10 percent of the total mass concentration of aerosols over the globe and this amount is associated with a high degree of regional variation (IPCC, 2007).

Intergovernmental Panel on Climate Control (IPCC): Climate Change 2007, the Fourth Assessment Report of the IPCC, Cambridge, United Kingdom and New York, NY, USA, 2007.

p. 13482 - line 4-8 - Liu et al. (2004) were not limited to total aerosol loading. They included vertical information from a chemical transport model, using an approach similar to van Donkelaar et al. (2006) cited later in this paragraph.

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The quotation of the paper of Liu et al. (2004) has been moved to the next paragraph highlighting the role of the knowledge of aerosol vertical profiles: Liu et al. (2004) proposed annual mean ground-level PM2.5 concentration maps using the Multiangle Imaging Spectroradiometer (MISR) AOT over the continuous United States but their study included vertical information from a chemical transport model.

To avoid confusion, individual symbols should only be used once in sections 3.2 and 3.3. alpha is defined as the scattering Angstrom exponent in the text (although "a" is used in equation 2 and on lines 9-10 of p. 13483), while αscat,700 is used for aerosol scattering coefficient. Also sigma is used for uncertainty in Section 3.2 and σext,355 for extinction cross-section.

The authors apologize for the different symbols used over the manuscript that could have introduced some confusion. To avoid this, we have chosen to define a as the Angström exponent and δi as the uncertainty on parameter i. αext and σext are the extinction coefficient and cross-section respectively.

p. 13482 line 26: α has been replaced by a.

p. 13482 lines 8-12:

The corresponding uncertainty δk1 on k1 is given by the respective uncertainties $\delta\omega$0, δa, and σC0 on ω0,355, a and C0, the slope of the regression analysis between αscat,700 and PM10: Eq. 3.

p. 13488 - line 14-16 - The numeric value of this "poor correlation" should be given, and for all fitted lines.

Done. Correlation coefficients R have been given in Sect. 4.1 for all the cases represented in Fig. 2: LISAIR in Paris (R 0.67), ESQUIF in Paris (R 0.39), ParisFog in Palaiseau (R 0.73), ESQUIF in Saclay (R 0.37) and MEAUVE in Brétigny (R 0.62).

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p. 13490 - line 17-19 - The authors should state over what period the agreement between nephelometer and lidar extinction coefficients was found. It is unclear whether this was during the campaigns in question, and if so, from how many measurements/ days, and if not, a citation should be given.

A figure has been added to illustrate this agreement between extinction coefficients derived from lidar and from nephelometer measurements (Fig. 3). Such an agreement was found on 13 and 14 March, 2007, in the framework of the ParisFog campaign, when the lidar was shooting horizontally at the same altitude of the nephelometer (4 m above ground level). The correlation coefficient is 0.88 and the slope of the regression analysis (0.92) corresponds to the single-scattering albedo of typical periurban aerosols, as shown in Table 1.

Section 6 needs to be improved prior to publication. It begins by comparing the lidar based PM at 200 m with ground measurements and closes by stating that such a comparison is meaningless, which it then says "suggests a good reliability of the approach developed in this study." The extinction tomography given in Figure 10 is relevant and interesting, but a single profile is not enough to completely disregard the poor agreement found with surface measurements (although the inclusion of the Chazette paper does start to build a case). A simple scatter plot of the ground PM with the lidar-based PM would make it easier for the reader to compare. Even if we disregard the ground measurements as suggested, we are, at best, left with no validation of the given approach and have no physically-based estimate of its accuracy. In no way can it be stated that this implies "good reliability" and this declaration must be removed.

The authors agree that the conclusion of a good reliability of the method is not provided by the comparison between lidar-based PM at 200 m with ground measurements. The approach is notwithstanding validated by the fact that the aerosol extinction coefficient

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derived from the lidar is in accordance with nephelometer measurements (Sect. 4.2 and Fig. 3), which are themselves in agreement with TEOM observations (Sect. 4.1 and Fig. 2). As a consequence the relationship between the aerosol extinction coefficient and the aerosol concentration (PM10) is linear for a given type of aerosol (Table 1) and the approach using lidar to retrieve mass concentrations is validated with an uncertainty lower than 30 % (12% for urban and periurban locations and 26% for a rural location, Sect. 4.2). Uncertainties have been computed using the well-detailed Eq. 3 taking account of the respective uncertainties of the various parameters in Eq. 3. This is a physically-based estimate of the accuracy since the different uncertainties are provided by observations (Table 1).

However, the disagreement between lidar-derived and ground-based PM10 values has required a discussion (Sect. 6): the corresponding discrepancies cannot be ascribed to the method (see above) but to other causes that have been investigated in this section: spatial heterogeneities between the different ground-based stations and vertical mixing in the lowest layers. This latter hypothesis has been tested thanks to the tomographic approach. Reviewer1 estimates that this case is not enough to completely disregard the ground measurements. The authors have therefore chosen to add a scatter plot of the ground PM10 with the lidar-based PM10, as suggested by Reviewer1. The result is shown on Fig. 12. The scatter plot uses all the data collected during the LISAIR campaign when the lidar was vertically shooting in fixed mode, i.e. when the lidar was not embarked onboard the small personal vehicle. Fig. 12 highlights a lack of correlation (R 0.08) between TEOM measurements and lidar-derived PM10 at 200m (average on a window of 20 m). This result confirms the strong decorrelation between observations at the surface and measurements performed at 200 m above ground level that were suggested by the tomographic approach and airborne measurements (Chazette et al., 2005b) and explains the discrepancies observed between mobile lidar measurements and AIRPARIF stations observations.

The conclusion of the good reliability of the approach is not at the right place and will

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be removed from this section.

Technical Corrections

All the technical corrections have been done.

Fig. 2: a constant ratio (of 1g.m-2) between the x and y axis limits has been maintained for comparative purposes.

Fig. 3, 7, and 8: The lower limit of the altitude has been given.

Fig. 3-9: The scale relative to the mean profile is logarithmic on Fig. 3-8 and linear on Fig. 9. Three axis labels have been given to avoid confusion and a larger width has been used for feature visibility.

Fig. 9: Time has been given in UTC.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 13475, 2009.

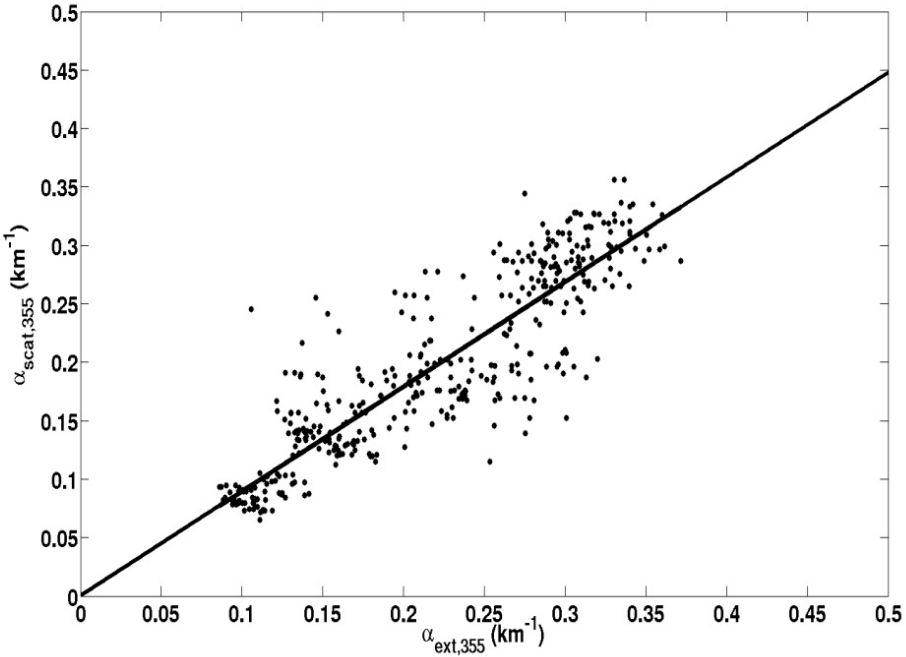

Fig. 1. Fig. 3: Correlation between the extinction coefficient at 355 nm retrieved by the lidar when shooting horizontally at ∼4 m above ground level and the scattering coefficient at the same wavelength deri

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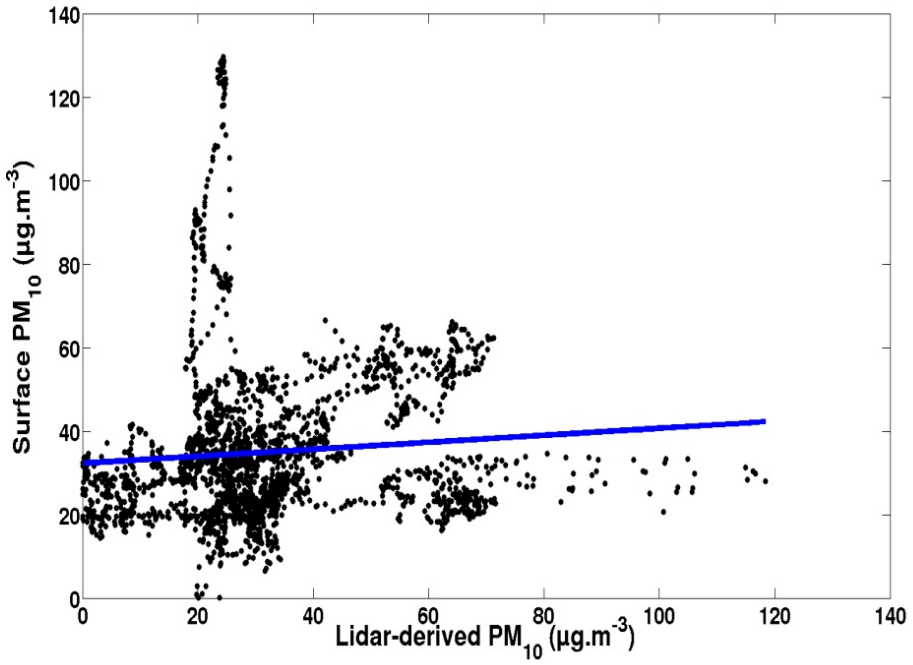

Fig. 2. Fig. 12: Correlation between surface concentrations measurements (PM10) and lidar-derived PM10 at ∼200 m during the LISAIR campaign when the lidar was vertically shooting on a stationary site in front

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