Atmos. Chem. Phys. Discuss., 9, C4688–C4693, 2009
www.atmos-chem-phys-discuss.net/9/C4688/2009/

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

Anonymous Referee #3

Received and published: 10 September 2009

General Comments:

This paper presents vertically and horizontally resolved estimates of PM10 in and near Paris, France, as determined from backscatter lidar data. The authors provide a methodology for computing PM10 from lidar observations and use this methodology to compute PM10 distributions from a mobile zenith-viewing lidar mounted on a vehicle that was driven around Paris and to/from Paris to outlying regions. Results are compared with measurements from surface sites in the Paris metro area. The influence of aerosol sources, meteorology, and dynamics on the PM10 distributions are discussed. The authors make a good case that the vertically resolved information from lidars can be very useful for improving understanding of aerosol processes and increase the accuracy of air quality forecasts. Some issues on the conversion of lidar observations

to PM10 estimates require clarification and uncertainties should be discussed more thoroughly. Also, the interpretation of the observations in terms of dynamics and evolution of the pollution layers is a little difficult to follow and conclusions in some cases are drawn without sufficient supporting data. The authors might consider making the paper more focused on a demonstration and accuracy of the technique for estimating PM10 from lidar data and deemphasizing the interpretation of the results. Overall, this paper merits final publication after some sections are clarified and a thorough edit on grammar and usage is conducted.

Specific Comments:

1. The abstract states that the paper concerns the role of the Paris Peripherique on local particle pollution. They define the Peripherique as a "ring" around Paris. For readers not familiar with Paris, they should define it as a highly trafficked "4-8 lane ring road" or "beltway" around Paris. However, more to the point, it is not clear to me that the paper actually quantifies the role of this freeway on local air quality. While many of the observations they present are from locations along the Peripherique and distinctions are drawn between the outer regions of Paris and the inner city, they do not actually estimate the contribution of vehicle exhaust from the Peripherique on air quality, nor are any conclusions in this regard offered in the Conclusions section. Hence this seems to be a misstatement of the content of the paper.

2. Section 4.2: Uncertainties in the calculation of k1 and k2 constants for converting lidar extinction values to PM10 were stated (12% urban and periurban, 26% rural). It would be helpful if the largest contributors to those uncertainties were listed. Also, it is not clear from Section 3 whether the uncertainties in the nephelometer measurements used to estimate the constants or the humidity corrections used to correct the nephelometer data were included in these uncertainty estimates. The authors should provide an explanation of the calculation of these uncertainties.

3. In lines 4-8 of p 13491, the authors indicate that a constant backscatter-to-extinction

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ratio (BER) of 0.011/sr was used to retrieve aerosol extinction from the lidar signals. This BER was determined from coincident lidar and sunphotometer data, presumably from a stationary site. (I assume that the sun photometer was not mounted on the vehicle used for transporting the mobile lidar.) A BER produced in this manner would provide a column-average BER for the conditions present during the coincident lidar and sun photometer measurements. The BER at any point in a profile will depend on the aerosol type and the RH at that point (due to hygroscopic growth), and hence can vary significantly with altitude. The authors should state how much data was acquired to produce this estimate, what times of day it was acquired, under what kind of conditions (aerosol type, RH), and the variability that was seen in the BER over time. The authors should also recognize that the extinction profiles computed using the constant BER estimate will have systematic errors due to differences in water uptake of aerosols in the profile. The authors do correct for hygroscopic growth in their conversion of the retrieved ambient extinction values to estimates of PM10. This does not, however, address the fact that the retrieved ambient extinction going into that calculation has errors correlated with humidity. The authors should attempt to bound how much of the vertical (and possibly horizontal) variation of the computed PM10 values is due to differences in RH rather than differences in actual PM10. They should also describe the source and resolution of the RH data used to make corrections for hygroscopic growth.

4. P 13492 line 10: The authors state that the k1 factor for periurban aerosols is applied to residual layers. Why assume these aerosols are periurban rather than urban? Some explanation behind this assumption is needed.

5. Page 13494 line 7-8: The text indicates that high values of extinction are seen between 2 and 4 km all day long in Figure 9a; however, the figure shows high extinction for less than half of the time shown in that altitude region. The text also talks about features in terms of UTC times (i.e., the elevated extinction at 3km starting at 1500 UTC) whereas the figure is labeled in local time. This is the only figure labeled in local time, which is a bit confusing. It would be better to stick with one time convention or at

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least use the same time convention (i.e., local time) when referring to that figure.

6. Comparison of lidar-derived and ground-based in situ PM10 measurements: In Table 3 and the discussion in Section 5, PM10 concentrations are given by layer. The authors should make clear how these values are calculated. That is, are they layer-average values? If so, they should also provide a table and or correlation plot of the PM10 values for the lowest altitude measured by the lidar along with the values measured by the ground-based in situ instruments. Some explanation or discussion of the differences between the in situ PM10 measurements shown on the figures and the lidar-derived values in the plots should be made early on. For instance, in Figure 6, the Les Halles in situ measurement was 33 micro-gram /mˆ2 while the lidar value appears to be >55 micro-gram /mˆ2. Line 12-13 of page 13493 indicates that the mass concentration goes from 30 micro-gram/mˆ3 in the early morning to 60 micro-gram/mˆ3 by mid morning; however, the in situ measurements indicated at the Les Halles site indicate values of 25 and 33 micro-gram/mˆ3 at those two times (Figures 5 and 6). The differences between the ground-based in situ and lidar measurements of PM10 are eventually discussed in Section 6, but not in the context of the scientific interpretation presented in Section 5. The results of one experiment with a scanning lidar were used to demonstrate a large decorrelation between the lidar and surface measurements; however, a single experiment seems too little evidence on which to make a conclusion and one wonders whether the vertical variability seen in the scanning lidar measurement was due to variability in aerosol loading or variability in RH with altitude (see comments on errors associated with constant BER assumption above). At the end of Section 6, the discrepancy between the lidar-derived and surface-based measurements of PM10 is given, but only an overall RMS value. In lines 26-30 of page 13499, the authors state that the RMS error was 14 micro-grams/mˆ3. This appears to be a significant fraction (between 25% and 100%) of the PM10 measurements reported in the paper; yet, they indicate that this value is “not important” and “suggests a good reliability of the approach”. A similar statement is made in the Conclusions section. It is not clear how the number can be both unimportant and also serve as proof of the tech-

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nique. More to the point, how can a large discrepancy between remotely sensed and in situ measurements serve to prove the reliability of the remote sensing approach?

Technical Corrections:

1. While generally well-written, there are too many errors in grammar and usage in the paper to correct via the review process. The entire paper should be gone over thoroughly by a professional editor.

2. Figure 1. Plot labels are too small and very difficult to read. Plot symbols and line styles are difficult to distinguish.

3. Figure 2: Plot labels are too small and very difficult to read. The white bars representing standard deviations of the parameters are too thin and difficult to see.

4. Figures 3, 4, 5, and 6: Are the black line circling Paris on the maps a geographic demarcation (e.g., the Paris city limit) or the location of the Paris Peripherique? The interpretation of the line should be labeled on the figure or indicated in the caption. One might infer from the route taken by the lidar in Figures 5 and 8, that the Peripherique is mostly but not totally coincident with the demarcation shown (i.e., the route taken by the mobile lidar on the west side of the map is not along the black line). If the line is a geographic demarcation, it would be better to show the line for the Peripherique, since that is a focus of the paper.

5. Figure 4 and 7: It would be helpful if the lidar plots included labels/arrows indicating where the lidar track intersected the Peripherique, as it is difficult to accurately determine locations by correlating the color coded time in the map plots to the time labels in the lidar plots. Figure 7 should also include an indication on the map of the A6 highway referred to in the discussion and the lidar plot should include a label/arrow locating the point in the lidar curtain intersecting that highway.

6. Page 13499, line 7: The authors talk about calibrating the lidar in the “Rayleigh zone”. This is jargon that would only make sense to a lidar specialist. They should

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indicate that the lidar was calibrated to estimated molecular returns in a region deemed to be of low aerosol loading.

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