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Atmospheric Measurement Techniques Discussions

Interactive comment on "Characterization and intercomparison of aerosol absorption photometers: result of two intercomparison workshops" *by* T. Müller et al.

Anonymous Referee #2

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Overall Impression: The authors have presented results from measurements made during two workshops on light absorption by aerosols as determined using filter-based absorption measurements. Given that such techniques are used to make long term measurements of aerosol light absorption around the world it is crucial that the precision and accuracy of these techniques is well understood and this paper provides an important step towards this understanding.

The unfortunate conclusion of the paper is that "current correction functions for absorption photometers are not adequate." The authors provide some useful suggestions towards how data quality can be increased (such as regular measuring of spot size and

flow). Nonetheless, the results indicate that even when such good practices are put into place (such as at this workshop) significant between instrument variability remains. Additionally, the authors importantly have found that the relative sensitivity of different instruments apparently changed over time when used to sample ambient aerosol. To me, this seems like one of the more important conclusions of the manuscript and I would suggest highlighting it in the abstract, in particular in the context of the robustness of long-term measurements of aerosol light absorption.

Specific questions and comments follow below, but a general comment is that at times I found this paper difficult follow. The paper is comprehensive and very detailed, but I found that the comparison between the measurements from the different instruments was somewhat hard to follow. At times it seemed that unnecessary detail is given while at other times the detail is insufficient to allow the reader to easily follow. Some of this I believe is a result of the PSAP vs. MAAP and aethelometer vs. MAAP discussions becoming too intertwined. My suggestion would be to use further subheadings within sections to highlight the different instrument comparisons. This could be followed with overall summaries which bring the results together (PSAP vs. aethelometer) at the end of each section. Overall, I find this to be an interesting and useful contribution to the field, but I would strongly encourage the authors in their revisions to focus on clarity in their presentation.

Specific Questions/Comments:

P1521.L17: The likely reason why these workshops did not focus on the effects of organics as they influence filter-based absorption measurements resulted from the timing of the workshops relative to the referenced work. To state that consideration of biases imparted by organics or other “liquid” aerosol was far beyond the scope of the workshops does not seem appropriate. Understanding such biases in detail is critical to quantitatively understanding the performance of filter-based absorption photometers in the real world. Without such knowledge, the quality of the measurements cannot be assured for anything but the test aerosols considered here. For example, a goal of

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these workshops is to establish methods to ensure high quality data that are comparable across many different sites. These sites may be impacted by aerosol with very different compositions and therefore with different associated biases.

P1525.L1: I recommend breaking this into three paragraphs where each paragraph deals with each instrument type in turn.

P1530.L7: The calculation of "R" appears to require knowledge of the single scatter albedo. Barring the use of other instruments, how is the SSA generally determined for use in this calculation? The SSA cannot be known until the absorption is known, but the absorption measurement depends on the SSA. Thus, the correction appears to be circular. For the purposes of this manuscript, it is stated that "All Aethelometers are corrected by the same experiment/measurement-period average f value." From which data is the average f determined? The MAAP + PSAP?

P1531.Footnote 2: It is not abundantly clear what is meant by this footnote.

P1532.L12: It is not clear whether the Angstrom exponents were determined from wavelength pairs (i.e. following from Equation 1) or from a fit to all three wavelength points. These two methods can give somewhat different results so it should be stated more explicitly how this was done.

P1533.L6: It is stated that the increasing standard deviation in the PSAP spot area measurements can be explained by "bad sealing rings." It is not abundantly clear why this would have a greater influence on the larger area spots. Related to this, it is not clear whether the actual spot (i.e. the cut out portion of the filter holder) or the spot produced on the filter from aerosol deposition was actually measured.

P1533.L24: Can the authors comment on why the average spot size would be lower during one workshop than the other? Did something in the design of the aethelometers change?

P1535.L26: I find much of Section 5.3 difficult to follow, in particular the definition of the

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"face factor" and the associated discussion. It is somewhat difficult to really understand what is being compared to what. Perhaps a table summarizing the comparisons would help (although there are already a lot of tables)?

Figure 3: Given the log scale, it is not clear why the ambient measurements needed to be multiplied by a factor of 10 for presentation. I suggest presenting the unscaled data to avoid confusion and give a more direct representation of the actual conditions.

P1537.L21. How was the noise/time relationship actually determined from the experiments? It is not clear.

Section 5.4: It needs to be made clear whether the authors are reporting standard deviations or standard deviations of the mean. How long was data collected for? As with Section 5.3, I find the discussion in this section to be somewhat difficult to follow. A better description of the experiment and the procedures used would be helpful.

P1539.L10: The need to convert the standard deviations to face velocity equivalent values is not overly clear. I would think that what is more important is the standard deviation under what could be considered "typical operating conditions," which could be determined from Section 5.3.

P1541.L8: A value of 0.79 is given here, but 0.81 is given in Table 10.

Figure 9: Why is it that all of the high absorption level data are at "high loading" while the low absorption data are at "low loading"? Upon first glance, the figure appears to show a major deviation between the PSAP and MAAP at high absorption levels, but presumably this is just because of the filter transmittance differences. Were there any periods where the absorption was high and filter loading low (and vice versa)? Also, it seems as if the fits have been forced through zero (although this was not stated). If the fits are not forced through zero then the discrepancy at high loadings will appear to be greater in terms of the slope and the intercept will be significant.

Figure 10: Again, was the fit forced through zero? It appears to be so, but this is not

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stated. What is the slope/intercept if the fits are not forced through zero?

P1543.L12: It should be clarified that the relative sensitivities are relative to the MAAP measurements. P1543.L10-21: The authors have found that relative sensitivities differ between campaigns. This suggests that the sensitivity may be a function of the ambient aerosol composition. As such, I'll pose the question that if the instruments are really this sensitive to the specific conditions of the ambient aerosol, then is there really any hope of obtaining accurate absorption measurements over long periods of time at different sites? How could one be certain that observed trends are actually a result of actual changes in aerosol absorption vs. changes in aerosol composition unrelated to absorption? I would suggest some discussion of this be included.

P1545.L13: The upper value given here is only 2.18%, but the largest value in the table is 3.12%. In the table it is indicated that this upper value has been excluded for some reason, but this is not explained.

P1546.L15 and P1547.L6 and Figure 12: Can the authors comment on why the scattering effect appears to level off at high filter loadings?

P1547.L13: Do the authors have reason to believe that in previous studies investigators would have used "dirty" filters at the start of their experiments? Certainly, this would have been indicated if it were the case. Given that one of the authors on this paper was also an author on the RAOS study paper it would seem that there should be direct knowledge of whether this was the case.

P1548.L8: I believe that the MAAP applies an internal correction. Additionally, the MAAP absorption values were all increased by 5% following comparison with a photoacoustic instrument. Thus, it appears that an empirical correction for the MAAP was actually applied.

Table 10 vs. Table 11: It is interesting that the aethelometer/MAAP ratio for the ambient aerosol during GAW2005 is only 1.37 while for carbon black it is 2.11 and 1.53 for

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the two aethelometers reported. Can the authors offer a reason for the dramatically different behavior of the ambient vs. carbon black results? The findings of Lack et al. (2008) (which suggest that OC may bias filter-based absorption measurements) would suggest that, if anything, the deviation in the ambient observations would be expected to be greater than for the carbon black experiments.

General: the authors spend a lot of time going over the results of the ambient aerosol observations and the standard deviations associated with these measurements. However, when it comes to the more constrained Carbon Black measurements the discussion is significantly less. Wouldn't the laboratory experiments with Carbon Black be better suited for detailed analysis as this takes out some of the uncertainty regarding aerosol composition? The conclusion that "differences between the absorption measured by the MAAP, PSAP and aethalometer cannot be explained" is unsatisfying and I suggest should be discussed further, particularly in light of the ambient measurements. Do the results from the carbon black studies suggest that the level of agreement between the different instrument types is worse than indicated from the ambient measurements? At minimum, I believe that the results from the carbon black studies should be mentioned in the conclusions alongside the ambient aerosol results.

Technical Corrections: Table 2: No values are reported for Carbon Black. P1529.L15: Berkeley is mis-spelled. Equation 14: This equation has sigma_*_abs, but the definition following uses sigma_*_ap.

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 1511, 2010.