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Atmospheric Measurement Techniques Discussions

Interactive comment on "Assessing the accuracy of low-cost optical particle sensors using a physics-based approach" *by* David H. Hagan and Jesse H. Kroll

Anonymous Referee #3

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This article uses Mie scattering theory to evaluate accuracy of three classes of optical particle sensors used in aerosol measurements: nephelometers, low-cost particle counters with limited size range detectability, and high end particle counters with wider size range, especially at the lower end of size spectrum. Manuscript is well written and addresses important factors affecting accuracy of particle measurements with an emphasis on mass loading calculations. Authors show the importance of three factors in evaluating accuracy of results from different optical sensors: particle growth in presence of humidity; difference between optical properties of the measured particles and those used for calibrating the instrument; and difference between the size range of measured particles with the calibration particles. My major concern about this article

is that it is rather incomplete at the present state. Following are a couple of ways in which I think this study can be improved.

1. More analysis needs to be done to demonstrate the importance of these factors in measuring real world particles. Examples presented in the text are simple hypothetical cases that just show the importance of each factor. It is important for the reader to see how much the results of actual atmospheric particle measurements get affected by these errors. Analysis of data from previous studies would be helpful to obtain a picture of how much those data would change if corrected for the effects. One major question is to see if the final conclusion from some of previous studies would be affected based on these factors.

2. The abstract and introduction create the expectation that this article would also address the interaction between different factors and the impact on accuracy of measurement results. However, presented cases are all single-factor studies. If authors believe the interdependence of these factors is significant, these mutual effects should be addressed in the paper.

Technical Corrections:

Title – "low-cost" word can be omitted from the title as this manuscript looks at low cast as well as "high end" instruments.

P5, L3 – Please provide a brief description of factors resulting in "changes in aerosol optical properties". P8, Table 1 – Have the authors tried contacting the manufacturers to obtain the data that is missing in the literature?

P12, L7 – Why is geometric mean used for mass calculations? Are the authors suggesting that they use the measured pulse heights from individual particles rather than assuming uniform size distribution across each individual size bin? If yes, what is the point of referring to size bins?

P12, L24 – Similar comment as above. Please clarify the reason for preferring geomet-

ric mean diameter.

P15, L9-10 –“overestimate” and “underestimate” would be more accurate terms for these sentences.

P15, L22-24 – The wording in this section is unclear. Do the authors mean that “very few low cost OPSs control relative humidity. . .”?

P16, L1- Should read “Figure 2 shows the impact that RH can. . .”

P17, L20 – Please add more explanation about Mie scattering of black carbon particles in the <300nm range. The trend shown in >300nm range is understandable based on the BC particles being more absorbing, but an explanation for <300nm range is missing.

Fig 5 – Please show the contour line corresponding to Mm/Ma=1

Fig 5 – It seems that even at the calibration conditions (GM=400 nm, and GSD=1.65), mass loading accuracy is not equal to unity in any of the plots. What is the explanation?

Table 4 – Need to mention that the main metric in consideration in this table is mass loading. Clearly, if the focus in a study is on evolution of particle size distribution rather than integral mass loading, nephelometer can’t be recommended.

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