Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2019-146-RC1, 2019

Atmospheric Measurement Techniques Discussions

Interactive comment on "Laboratory Validation and Field Deployment of a Compact Single-Scattering Albedo (SSA) Monitor" *by* Julia Perim de Faria et al.

Anonymous Referee #1

Received and published: 29 May 2019

This manuscript provides an analysis of a set of laboratory experiments comparing the recently developed CAPS PMssa instrument, which measures aerosol extinction and absorption (from which is derived single-scatter albedo) using cavity phase-shift and integrating sphere techniques, respectively. Because this instrument can determine SSA through from a single sample, and bypasses the need for relatively uncertain absorption measurements using filter media, it has the potential to be extremely valuable. The aerosol direct effect remains a large uncertainty in the Earth's radiative balance, and this instrument, if accurate and widely used, has the potential to help reduce this uncertainty. The topic is entirely within the scope of AMT and there should be many readers interested in the subject. The experiments described in the manuscript appear

to be well conducted and have produced high quality data.

Regrettably, there are some significant issues with the manuscript, two especially, that will require a major revision. These two issues are:

1) There is no error analysis of the techniques being compared. Instead, variance in the measurements is used as surrogate for uncertainty. The authors need to directly and independently determine the uncertainty in the phase-shift extinction measurement and the uncertainty in the scattering measurement, and propagate these uncertainties through to the final SSA product. This uncertainty analysis must include consideration of both potential biases (which might include determination of pressure and temperature in the instrument, for example) and random uncertainties (which might include noise in the measurement that requires averaging). As it currently stands with this manuscript, if I were to purchase two of the CAPS PMssa instruments and compare them and find that they disagree by 5% in extinction and/or scattering, I would not know if this is within expectations or would indicate a problem with one of the instruments. A complete uncertainty analysis needs to be applied to all the instrument combinations used. In Table 6, it is not at all clear where these "uncertainties" come from; they appear to be either the scatter in the data (plotted in Fig. 12) or else the difference between the mean values of the data and the "expected" values of the calibration aerosols. Because the SSA of the calibration aerosols is not truly known, there is no absolute standard provided against which to evaluate the different approaches to measuring SSA, so a fundamental uncertainty propagation is needed.

2) The linear regressions which provide the bases for the evaluated values appear to have some sort of error. Examining Fig. 4, the fitted line shown on the scatterplot lies below all of the datapoints. Using Table A1, I plotted the data shown in Fig. 4 and performed a linear regression. I got a slope of ~1.08 and the fitted line passed directly through the data. This compares with the "all" fit shown in Table 3 of the manuscript, which gives a slope of 0.97. I tried a two-sided regression, a one-sided regression, and one-sided regression forced through zero intercept. All gave slopes >1.06. Inspecting

the other scatterplots in the manuscript (e.g. Figs. 8, Fig. 11 for absorptions <70 Mm-1), the fitted slopes do not seem to go through the data. Unless I've made an error, it appears that the values appearing in all the tables are suspect because of this fitting issue. Thank you for including all the data in the supplemental material tables, which makes finding an apparent problem like this easier.

In addition to these two principal issues, there are some smaller items that need addressing.

a) The table captions all need to be more precise. For example, Table 3 might have a caption of, "Linear regression parameters slope (m), intercept (b) and their standard deviations and the linear regression coefficient R2."

b) I was trying to understand for quite some time how the column labeled "SSA" in Table 3 was calculated before realizing that it is simply an estimate of the SSA for the aerosol type being generated. It might be clearer to move the SSA column to the second column of the table and label it "estimated SSA".

c) The figures all need to use a heavier line width and larger, denser font. It is quite hard to read the labels and identify the symbols and lines.

d) The descriptions in the tables and figures of "PSAP-Neph" is confusing; it suggest that you are subtracting the scattering data from the absorption data. I suggest you use PSAP+Neph for Table 1 and Fig. 4, and "PSAP & Neph" for Table 6.

e) Figs. 5 and 9 are not needed since the data appear in tables already.

f) Fig. 12 should also show the SSA determined for the ammonium sulfate aerosol; this would give a good idea of the scatter about a known, non-absorbing compound.

g) The title includes "Field Deployment". There is no field deployment of the instrument described in this manuscript, just laboratory tests.

h) Lines 93 to 97, the description of the roles of MFC#1 and #2 in regulating make-up

air appear to be switched with MFC#3 and #4 in Fig. 1.

i) Section 2, please describe the truncation angles for the various instruments and typical magnitudes of the correction factors. The uncertainty in these correction factors need to be part of the total uncertainty analysis and error propagation.

j) Please use 2-sided (orthogonal distance) regression when performing the linear regressions. There are uncertainties in both x and y dimensions that should be accounted for. Please weight the regressions by the uncertainty in the measurements.

k) The figure captions (e.g., Fig. 3: "Time series of the measurements by the extinction channel" do not adequately describe the contents of the figures, which in this case shows results from 3 different instruments/combinations, not just the extinction channel of the CAPS PMssa. The same for the other time plots.

There is a lot of good information from some carefully performed and important laboratory studies in the manuscript. I encourage the authors to address the concerns indicated above and submit a revised manuscript that more fundamentally addresses uncertainties and that uses accurately determined regression slopes using properly weighted 2-sided linear regressions.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-146, 2019.