Atmospheric Measurement Techniques Discussions

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Comment on amt-2022-42

Anonymous Referee #3

Referee comment on "Correcting for filter-based aerosol light absorption biases at ARM's SGP site using Photoacoustic data and Machine Learning" by Joshin Kumar et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-42-RC3, 2022

General comments

Kumar et al. describe a very interesting comparison of "traditional" PSAP correction algorithms with a new machine learning algorithm. The work is important and can contribute significantly to the painful post-processing of the filter-photometer data in general. Filter photometers are used widely and in very different environments, so an algorithm that reduces the bias with no or very little assumptions is most welcome.

The reviewer will take the unusual action of sticking to general comments (under several titles) and have only two specific ones. The importance of the results is unfortunately influenced by the hastiness and shallowness of the writing. There is a definite lack of attention to detail. The paper should be heavily revised and reviewed afterwards. It definitely deserves publication – the improvement in the regressions between the PSAP and PASS is impressive.

Terminology and parameters

What is B_PSAP?

What are "uncorrected filter-based absorption raw signals"?

The statement (line 138) that "this overestimation…" – by filter pohotometers, "… is due to the enhancement of light absorption by the filter deposited aerosol due to scattering based artifacts" is misleading. The enhancement is due to scattering of light by the filter fibers. Part of the reduction of light intensity below the sample is due to scattering (away from the forward direction). This is correctly summarized in Eq. 1, but not here. The separation of these two effects is artificial (Mueller et al., 2010). This should be discussed, especially in light of the superiority of the RFR algorithm.

The authors should use notation and naming of the parameters consistent with Ogren et al (2017). I suspect that the "uncorrected filter-based absorption raw signals" are in fact the attenuation coefficient. If this is so, please use this parameter. The "raw signals" could be interpreted as raw intensity signals measured by the photodiode… Please be precise.

Also, the absorption coefficient is derived, not measured, by filter photometers. The authors correctly state this, but then relapse into claiming that the absorption coefficient is "measured" by PSAP.

What is he reason for including Eq 4 before Eq 5?

It is never referenced.

Measurements

Start by explicitly stating the period under investigation. This sets the stage. It seems there is 6.5 years of collocated PASS and PSAP data, yet the authors use only 3 months?!

Which filter was used in the PSAP?

Pall, Azumi, anything else… - see for example Ogren et al., 2017 for the difference in regression slope.

Was the inlet dried? Was there a cutoff? How was the flow split? Were the ACSM measurements performed in the same size fraction?

Please provide all relevant details!

The authors state that SSA is not available. This is probably not true, as the ARM web page:

https://www.arm.gov/capabilities/instruments?category=aerosol&type=armobs&site=sgp

states that there is a neph installed at SGP from 4 Oct 2010 onwards. Include the scattering data everywhere as it will improve the corrections, especially the Virkkula 2010 corrected algorithm.

SSA is fundamental in terms of the overestimation of derived absorption using filter-photometers (Weingartner et al., 2003; Virkkula et al., 2015; Yus-Díez et al., 2021). The analysis of the performance (see below on the comment which parameter to use) of the algorithms as a function of SSA should be investigated.

Similarly, ACSM measurements are supposed to be available from 18 Nov 2010 onwards. The selectio of only 3 months makes the huge OM event starting on 2015 07 07 very important when looking at the “average” picture – it heavily skews the data, if using averages, especially since the PASS and PSAP were not working consistently during this period. The ACSM measurements could be used to a higher degree in the interpretation of the results (see also below).

What is the relevance Fig A2, showing, among other things, negative OC?

The period is 2 years prior to the measurement campaign.

The authors use negative AAE derived from the blue/green wavelength pair for inter/extrapolation. Such values are highly unusual and require major attention. There must be an error somewhere, since other AAE values seem closer to what one would expect. The OM event probably has a huge influence on AAE. What happened, a large fire?

Data processing and Algorithms

How were the period with incorrect, suspect, and missing values identified? What were the criteria?

How was averaging performed? Was the Springston and Sedlacek (2007) algorithm used? It should be at least investigated, there is an interesting example by Backman et al. (2017) which could be followed.

The reason for using the average of Virkkula (2010) and Ogren (2010)-Bond (1999) is described only briefly. It would help to treat each separately and then show the average (which is used in processing of the data). One expects a comment also on why is this paper better than Arnott et al. (2005).

How is the training/testing split 70/30 determined?

More details need to be provided. Why is the learning period twice as long as the test one? What happens if the periods are extended (6.5 years of data!)? Is the 70/30 split pre-defined by a human or is this some sort of a Monte Carlo sampling?

The RFR method is empiricistic. It would be of great interest to check its performance in periods of different SSA… to see what are the real parameter of interest (see the back-scattering coefficient and SSA in Virkkula et al., 2015)?

The reviewer is not sure that RMSE is the correct parameter to estimate the performance of the correction algorithms. It assumes the error only in the PSAP measurements. While this is true for "bias" assuming that PASS is the "absolute truth" (see above), but it is not true for experimental noise.

What is the cause of RMSE wavelength variability? Noise? This is algorithm independent – green regressions are always best.

Results

Why is the number of points in the regression on Fig 5 (RFR) lower that for other algorithms?

Miscellaneous

I am curious: could you derive Virkkula parameters with the RFR algorithm?

The laboratory experiment (Section 3.5) is very different but interesting. There should be more experimental detail.

Specific comments

Please spell check the manuscript!

Please use the dates in global format (18 Nov 2010), so that our colleagues from outside the Americas will understand them without ambiguity.

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