Comment on amt-2021-403

Anonymous Referee #2

Referee comment on "Look−up tables resolved by complex refractive index to correct particle sizes measured by common research−grade optical particle counters" by Paola Formenti et al., Atmos. Meas. Tech. Discuss.,
https://doi.org/10.5194/amt-2021-403-RC2, 2022

Review of 'Look−up tables resolved by complex refractive index to correct particle sizes measured by common research−grade optical particle counters'

This paper provides a database of corrections to 5 widely-used OPCs for aerosol measurements, accounting for different aerosol types via the complex refractive index. This publication is a very much needed contribution to standardize the process of correcting measured size distributions.

The authors present a well thought out approach and associated database which should be widely used by the community. The article is well-written and mostly clear to interpret. Some figures are of poor quality and need improvement. One limitation is that only one refractive index is provided for non-spherical mineral dust, while an array of values are provided for spherical aerosols. The article could do with some balancing out of the criticism of OPCs between the data analysis/examples section vs the conclusion. Specific points are given below. Overall this is a high quality paper which I recommend should be published subject to minor revisions.

Specific Points

P4-5, l131-137 (points 1 &2) – it's not really very clear precisely what these points mean.

P6, l172 – 'nominal' presumably refers to D_EO given in table 1 – this should be confirmed in the text or table to avoid confusion.

Table 1 – '$' symbol within the table itself appears to be missing?

P7 l209 – expand NIST

P7 l211 – is there a reason the CDP is calibrated with different beads?

P8 L235 – please make it clear in this line that you are now describing the work in this paper

P8 L240 – the maximum imaginary part k appears to be less than a typical refractive index for black carbon aerosol (~0.8) – can the authors justify this or explain why they did not represent such absorbing aerosols?

P8 L243-249 – this is a very long sentence, please shorten.

P8 L249-252 – I think I must be misunderstanding this text. It sounds like the authors use only one value of CRI, regardless of wavelength. If that is the case why is the NIR spectrum relevant? Why select an upper bound rather than mid-range? The Di-Biagio 2019 data should be considered superior to much of the data shown in their Fig 8 due to the improved method compared to some of the much older work shown in that figure. Please be clear about the approach. Was only one CRI value used for the non-spherical calculations? 0.003i seems slightly on the large side to be representative of the latest body of literature for mineral dust at wavelengths of ~600nm.

Using only one value of CRI for non-spherical dust rather limits the value of this aspect of the paper. The authors show that non-sphericity has a large impact on the resulting OPC size distribution. However, the CRI of dust is far from agreed on, which makes selecting one value only very limiting. I strongly recommend to the authors that they add additional CRI values to extend the usefulness of this dataset.

P8 L243-252 – The description of the specific methods used for non-spherical shapes are quite brief. Given that the methods here are important in determining the final scattering properties of these aerosols, some more detail is needed, beyond just the citation of Huang et al. (2021). E.g. How/why were the different methods used? (Mie/T-Matrix/DDA). For which particle sizes? Please provide more details on the 'globally representative shape distribution?'

P8 L256-261 – this may be confusing to readers not explicitly familiar with the process of adjusting diameters in OPCs. Could the authors add a figure to demonstrate this process, or perhaps add some annotations to fig 1 to better explain? How is the closest value of D_{geo} selected when Mie oscillations mean that multiple values could be selected? The use of bin mid-points vs edges is not entirely clear.

P9, section 3 – please make explicitly clear that file types 1 and 2 are for spherical particles.

Fig 2 – Appears to span several pages currently. Please take care that these images are not shrunk at the production stage, as the smaller details are important.

Fig 1, relating to text p10 L319-322 – it would be useful to add a light colored horizontal line on each lower panel plot at a value of 1, as this is an indicative value of dlog(Csca)/dlogD.

Fig S1 – the color bar should be changed so that there is a clear color difference at a value of 1 for the reason above. Alternatively a solid line could be added to the figure at a value of 1. Otherwise it is very difficult to identify figure regions where the OPCs are less sensitive.

Figs 3, 4, 5, 6 – these figures are not very clear – lines blury, axis text too small.

Fig 4 – D_{EO} and D_{geo} in the figure should be formatted in the same way as these parameters are in the text (i.e. not Dgeo and Deo). The 1:1 line should be shown to allow better interpretation.

L335 – 'Fig 5' should in fact be 'Fig 4'?

Fig 5 right hand panel – this would be easier to interpret if the minimum diameter was reduced to 1 micron, corresponding to the two left hand figures.

Table 2 and P12 L372-389 – could the 'true' values be provided, as calculated from the initial lognormal distribution taken from Seinfeld & Pandis? This would be useful in putting the different methods in context, including the base case, which discards certain data.

P12 L372-389 – it would be useful to lift some numerical values from the tables to make this discussion more explicit.

Section 4.2 – this section largely focuses on the CDP and mineral dust. Do the authors feel that this combination of instrument/aerosol type is one of the most affected by the issues described? If so/if not, a final paragraph in this section should be added to give a slightly broader context on how these issues translate across all instruments/aerosol types, or to explain why the CDP+dust choice is so prominently described.

P13, L400 – "In general terms, the analyses described confirm that research−grade OPC probes perform very well for the size ranges and for the particle types for which they were designed…' in contrast to (from p10 L322), "…while the asymptotic value of 0 represents the situation when Csca is independent of size and the OPC cannot be used to classify the particles." – the outlook in the conclusion comes across as fairly optimistic in terms of the use of OPCs for aerosol sizing, while the analysis in section 4 comes across as fairly negative, with many instruments showing values of dlog(Csca)/dlogD between 0 to 1 at many sizes. I feel the authors need to do a better job at linking the details in section 4 to their overview and outlook, and making sure they are consistent.

P13, L403-405 – "This contrasts with the relatively poor documentation of low cost sensors that are indeed useful for complementary applications such as distributed monitoring of air quality (Hagan and Kroll, 2020)." – can the authors expand on this? It sounds like these instruments are not appropriate for measuring the targeted size ranges (in contrast to the previous sentence). What sort of sensors do the authors refer to?

P13 L411 – The CDP shows similar dlog(Csca)/dlogD values across all size ranges (not just below 10 microns) – how does this affect how problematic it is across the full size range?

The size range between 1-10 microns appears particularly problematic across (all?) instruments – it would be useful for the authors to comment on this, since many aerosols exhibit sizes in this range.

P13 L 419-422 – should the onus also be on manufacturers to make this information available?

P13 L 425-430 – this finding is an important conclusion which should be noted in the abstract

Significant improvements to size distribution estimations and corrections have been proposed by Rosenberg et al. (2012) (using uncertainties due to Mie oscillations) and

Walser et al. (2017). The authors should discuss these methods, considering differences and advantages/disadvantages to the methods described in this paper.

The authors describe corrections to particle size for 4 commercial OPCs. While I do not suggest adding more instruments, as the list could become very long, it would be useful for the authors to make suggestions for users of other instruments in the approach they might take to perform similar corrections for different instruments.