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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

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Low-cost sensors (LCSs) are widely used now-a-days for objectives ranging from citizen awareness to scientific research. Many studies have been conducted to evaluate commercially-available LCSs (including by my group), but systematic design-based analyses have been lacking. The recent He et al. (2019) https://doi.org/10.1080/02786826.2019.1696015 and this submission are important steps towards overcoming that shortcoming.

Some specific comments are listed below, but a broad comment is that the results as presented could be made more useful with simulations that consider widely-used

commercial devices.

- For example, common high-end OPSs (TSI 640, Grimm 180) do not measure down to 100 nm, but rather to 180-200 nm. (The Handix POPS - a really nice instrument! I want one! - is not commonly used for ambient PM measurements and probably gets overwhelmed by ambient PN outside of balloon flights.) I suspect this higher cutoff will significantly worsen the performance of the high-end OPC presented here, but it will be more realistic.

- The nephelometer collection angle used here is 7-173 degrees, which may be true for expensive TSI-type nephelometers, but such data are not available for LCSs (as shown in Table 1). The best data might be from Kelly et al. (2017) http://dx.doi.org/10.1016/j.envpol.2016.12.039, who say the Plantower collects scattered light at 90 degrees and the Shinyei at 45 degrees. It might help if the nephelometer results presented in this manuscript instead used 90+/-45 degrees or a similar range (or maybe the Plantower company can provide that information?)

- Finally, a key difference between the results presented here and sensor performance in the real world is that manufacturers may calibrate the sensor to ambient urban aerosol. This appears to be the case for Plantower - we were told (Malings et al. 2019) they calibrate to reference monitors in Chinese cities. (Met-One NPM is calibrated with 600 nm PSL.) Would it be possible to use a "typical" Beijing PSD instead of the ammonium sulfate calibration basis in the nephelometer results presented here?

I admit some of this may be more complicated and a lot more work, but people wanting to use the opcsim software may invariably want to do just that... And might turn to Dr Hagan for assistance anyway! Might as well get ahead of the curve and also get it published.

Specific comments: Page 15, line 8: what is "actual PM2.5 mass"? Is that the mass at 35% RH (like EPA regulations)? Please specify.

Page 16, lines 18-20: wouldn't the "missing mass" problem be present at all humidities, just (over)compensated at higher RH due to hygroscopic growth?

Figure 2: Some of these results are hard to decipher on a log scale. Maybe show it on a linear scale? (The marine case seems to be an extreme/can be moved to SI?)

Also in Fig 2, at least in Malings et al. (2019), we showed errors in the as-reported Plantower data as a function of RH (Table S2). Perhaps a more RH-resolved comparison could be made?

Page 18, lines 4-6: Can RI changes really cause such significant mis-assignment? Maybe at the margins/bin boundaries, sure. But the PSL, SOA, ammonium sulfate Mie curves (Fig 3) are pretty close to each other, and these are the dominant PM2.5 components by mass and (probably, OPC-wise anyway) number.

Page 19, line 9: "calibrated using PSL", not ammonium sulfate? (PSL matches the RI in parentheses and the caption of Fig 4.)

Pages 24-25: "some proxy for aerosol composition" - In Malings et al. (2019), we used PM composition data from the EPA CSN network (139 sites across the US, Fig S4) with a wide range of chemical composition and found the results did not change significantly (Fig S5), so long as some fRH correction was used. Might be relevant here.

Page 25, line 11: "therefore" not "therefor"

Page 25, line 24: are urban OECD aerosol size distributions "highly variable"? This might be another example of "errors that may not be significant in the US/EU but are important in developing countries".

Table 4: some issues with this:

- "small PSD" or "large PSD" suggests narrow or broad size distribution, but I suspect the authors mean "smaller aerosols" or "larger aerosols". Please clarify.

- NIST urban aerosol - SRM 1648 was collected in 1976-1977 and may not be repre-

sentative of, well, anything these days...

- Maybe the "aerosol properties" column should have some references?

- The authors emphasize this table is only a start, so it's fine to include it, I guess. There could be an entire workshop devoted to Table 4...

Throughout: Malings et al. (2019), not Malings et al. (2020). (I don't know why T&F's "download citation" shows the year as 2020. The paper was published in June 2019 and my downloaded PDF shows 2019 as the year for citation.)

Throughout: "The pluralization of abbreviations, too, requires no apostrophes. More than one CD = CDs... Etc." - Benjamin Dreyer, Dreyer's English (2019). See also: https://www.chicagomanualofstyle.org/qanda/data/faq/topics/Plurals.html?page=1

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