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Atmospheric Measurement Techniques Discussions

Interactive comment on "A low-cost monitor for measurement of fine particulate matter and aerosol optical depth. Part 1: Specifications and testing" *by* Eric A. Wendt et al.

Anonymous Referee #1

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Wendt et al describe the design and testing of a low-cost monitor that simultaneously measures PM mass and optical depth. The manuscript is topically relevant for AMT and is generally well-written.

I have several comments below, and they generally reflect my opinion that the paper is a bit "light" and would benefit from having certain sections fleshed out in more detail. There are three figures of results (Figures 3-5), and one could argue that Figure 3 is the only one that presents truly new data. As the authors note, the AMOD is an update on the UPAS, so Figure 4 to some extent repeats the validation work for the UPAS. Likewise, several papers cited by the authors, as well as Zamora et al (DOI:

10.1021/acs.est.8b05174), have tested the Plantower sensors, so Figure 5 is not a completely novel result. My comments below reflect places where, in my opinion, the authors could add additional detail and strengthen the paper.

Major comments

(1) Equation 5 assumes that all of the unit-to-unit variability in the photodiodes can be quantified with one voltage, and that all units can be scaled by a single "master" unit. I think that the authors should expand on this discussion and explain how robust of an assumption this is. Even if we assume that all of the manufacturing tolerances are tight (such that manufacturing defects don't contribute to unit-to-unit variability), my overall impression is that many low-cost systems rely on components that can have high unit-to-unit variability. How safe is it to assume that all of that variability can be captured with one parameter?

(2) The long-term robustness and/or drift of the various calibrations, or of the photodiodes themselves, is not discussed. What is a reasonable lifetime for an AMOD? What component is expected to fail first?

(3) AMOD operation relies on the unit remaining still for the entire 48-hr sampling period. How can data be QC'd to make sure that the AMOD didn't move? This is discussed qualitatively on page 9 in the paragraph starting on line 5. However I think it would be much more effective if the authors could show an instance when an AMOD was operated properly and contrast that with an occasion when it was operated improperly and moved. Also, how much movement is tolerable? One can easily imagine the extreme case where someone moves the tripod. But what if the tripod shifts or shakes in the wind? How much does that impact data quality?

(4) Interpretation of the AMOD data seems to implicitly assume that the environment is relatively stable over the 48 hours of measurement - e.g., that PM2.5 concentrations are relatively constant and/or that hours 0, 24, and 48 have similarly sunny conditions. What happens if these conditions are not met? For example, what happens if there

is a large change in PM2.5 concentration over the course of the two days? I could imagine several ways that this could happen, with potentially different impacts on the AOD/PM2.5 relationship. For example: (1) a photochemically active day with high secondary PM could be followed by passage of a weather front or a rain event that dramatically lowers PM2.5, (2) a plume from an industrial source or a wildfire impacts the AMOD site for a portion of the sampling period. Perhaps this means that AMODs are best suited for use outside of urban areas where there are fewer sources.

(5) Figure 4 shows the agreement between the AMOD and FEM PM2.5 measurements. Is the scatter in the data simply a reflection of uncertainty in the AMOD filter measurements? Or are there certain conditions (e.g., meteorology, PM composition on a given day) that lead to better or worse agreement?

(6) How do the authors expect the AMOD to perform in a different environment? My general impression is that the Colorado Front Range is a great place to test the AMODs, since it is often sunny. I'm typing this review in a location where 24 hours ago it was sunny, today the sun is obscured by clouds and there is intermittent rain, and tomorrow will have a mix of clouds and sun. How well do the authors expect their sampling strategy to work in the many parts of the world where day-to-day weather, and even within-day weather, can be extremely variable?

(7) Fig 5 - Does this figure show the raw Plantower output adjusted for the filter measurements, or is some sort of humidity correction also applied?

Minor and Grammatical comments

(1) In equation 3 I assume that tau (with no subscript) is the total optical depth due to aerosol, ozone, and scattering. This is not stated directly in the text. Please clarify.

(2) Page 3, Line 7: The greater than sign seems like it should come before 30.

(3) Page 3, Line 30: UPAS is undefined

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