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Atmospheric Measurement Techniques Discussions

Interactive comment on "Measurements of $PM_{2.5}$ with PurpleAir under atmospheric conditions" *by* Karin Ardon-Dryer et al.

Anonymous Referee #2

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This is an informative manuscript that evaluates the performance of networks of the PurpleAir PA-II low-cost aerosol sensor in real-world use. These sensors are commonly purchased by private citizens and installed, sometimes haphazardly, in residential and commercial neighborhoods. They are quite low-cost (<$300/unit) and data from these sensors could be used to increase understanding of the spatial distribution of PM2.5 and supplement more comprehensive, but much more costly and less ubiquitous, air quality monitoring stations (AQMS). The real question is whether these sensors provide data of adequate quality to be useful.

The paper is generally clear and well-written, and it makes a strong case that the sensors have value and can provide scientifically useful information, at least under the conditions evaluated. It is also nice to see a high school student involved in the study.

That said, there are some changes that need to be made to improve the manuscript. In particular, the evaluation of the sensitivity of the sensors to relative humidity (RH) and temperature (T) needs to be reworked, and some of the information in the tables could be presented more effectively with graphics.

Below are major concerns, followed by a couple of minor issues. I have not checked the references for completeness.

1) In section 3.3.1, the effect of RH and T on unit performance are evaluated by regressing these values against the PM2.5 values from the PA-II units. Unsurprisingly, there was no significant correlation against either of these parameters. Instead, what needs to be compared is RH and T against the *difference* between the PA-II units and the nearest AQMS values. Biases associated with T and RH are minimized in the AQMS sensors but would show up in the PA-II sensors, which do not control sample RH or T (although T is higher inside the sensing elements; thus we would expect RH to be reduced significantly below ambient). Any large bias associated with RH or ambient T should show up in this comparison (except see minor comment (b) below).

2) There are a lot of values in tables in this manuscript, many of which really belong in the supplemental information. I would much prefer to see a new figure with scatterplots of each sensor against the AQMS values in the main text, and move Figs. S1 amd S3 there as well. The detail in the tables should be moved to the SI.

3) The linear regressions should be performed with "2-sided" regressions because there is uncertainty in both the x and y values of the scatterplots. Standard linear regression assumes uncertainty only in the y values. I also suggest you remove obvious outliers (for example, the July 4th fireworks smoke) before performing regressions; these outliers can severely torque the slopes and r2 values.

4) There is lack of specificity in the abstract and throughout the text about "co-located" and "same location". I was quite confused when first reading the abstract, because it says that this manuscript reports analysis of PA-II units that are not "co-located" with

AQMS sites, but then in the next sentence that "we selected eight different locations, where each location contains multiple PA-II units (minimum of seven per location, a total of 86 units) and at least one AQMS (total of 14)." This sounds to me like "co-located" because you have not specified the criteria used for selecting PA-II units. I suggest you use "nearby" or "regional" rather than "location" throughout the text to avoid confusion. And please define the distance criteria for which PA-II units were selected for comparison with AQMS instruments.

5) You may want to explore the seasonality of differences between the PA-II units and the AQMS values. For example, in winter in Utah, I would expect big gradients between airport sensors on the flat plains and residential sensors on the slopes. This may become evident in the analysis I suggest in comment (1) above.

The take-home message to me is that the sensors are surprisingly good. If outliers are removed and sensors compared against others in the region for basic quality control, there is scientific value in the spatial information gained from networks of these cheap sensors.

Minor comments:

a) Lines 151-164. These are not needed; this information is already in the tables.

b) In Sect. 3.2.2., these differences between the AQMS values and the PA-II data in Utah in winter may be associated with the volatility of ammonium nitrate, which dominates the aerosol composition there (Womack et al., https://doi.org/10.1029/2019GL082028). The PA-II instrument would be less likely to volatilize ammonium nitrate, while the NAAQS FRM does volatilize it (Grover et al., https://doi.org/10.1029/2004JD004995).

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