Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2019-396-RC1, 2019

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 #1

Received and published: 10 December 2019

The work by Ardon-Dryer at al present a large database of PM2.5 mass concentrations collected by a low-cost sensor, the Purple Air PA-II unit across eight locations in the USA. At each location, there were measurements from multiple PA-II units, and the closest air quality monitoring station (AQMS) data was also acquired. The authors have performed a large amount of analysis on this dataset comparing the PA-II to reference instrumentation. However, it was not clear to me what the scientific novelty of the paper was, as there have been a number of papers already that evaluated the Purple Air sensor, as mentioned in the introduction. The authors state that the aim was to 'examine how PA-II units perform under atmospheric conditions when exposed to a variety of pollutants and PM2.5 concentrations', yet this is a rather vague aim, that this dataset may not be suitable to answer. This is a great dataset that could be

used to investigate a number of interesting questions regarding low-cost sensors and their calibration and suitability for large scale deployment. I feel that this paper suffers from a lack of focus and could be improved if the authors articulated and addressed more novel, detailed and specific aims and objectives. This leads to another area that could be improved, as most of the analysis is rather descriptive and lacking in depth. In my opinion, it is not enough to just present the regression analysis for all the PA-II units (i.e. r2, slopes etc) to the AQMS instruments. For example, there could have been more analysis on why there was a large range in observed r2 between all the unit and the AQMS? Was there any common factors for units that had a poor or good correlation with the AQMS? Did the actual reference instrument at the AQMS site affect the correlation (e.g. between FRM and FEM instruments)? I would have also like to have seen more focus on the observed slope between PA-II and the AQMS, as this is a better indicator of the accuracy of the PA-II than the correlation co-efficient (r2).

One of the key issues with this dataset, as acknowledged by the authors in section 3.3.3, was that the PA-II units were not co-located with each other or the AQMS and could therefore diminish the ability to compare the PA-II to reference instruments. Unfortunately, in my opinion the authors did not adequately address this issue. It would have been interesting if a more in-depth analysis of how the PA-II relationship with reference instrument varied as function of distance, as this would be of great interest to the community. The paper is well written and clearly presented but the large volume of data presented did make it difficult to follow at times. For example, the tables are too big, and could do with either being separated by city, or only the pertinent information being included.

In addition to the above, number of more detailed comments are given below Abstract: When you state that the units had good agreement it is important to back this up with numbers, such as giving the slopes, r2 etc. This generally true throughout the paper.

Page 2, line 63: In addition, the authors could reference Crilley et al 2018 and Di Antonio et al 2018 for possible solutions to the RH effect on low-cost PM sensors.

Page 5, line 152: this paragraph could instead be presented as a table. Furthermore, it may also help the reader if you were to give the AQMS and PA-11 units more accessible names. For example, the Pittsburgh AQMS could be P-AQ-1 and 2, and the PA-II units, P-PA-1, 2, 3 etc

Section 2.4: more info is needed on the data analysis, what sort of regression analysis did you do? In what computer program? Which AQMS station did you use, the closest or each one for a given city?

Section 2.6: I do not see the point of calculating the AQI when the point of this article is to compare the measurements between the PA-II and reference instruments. If they report the same concentration, wont they give the same AQI? I think you should just focus on reported concentrations.

Section 3.1.1: If Fig 2 is on page 29, then this is not a distribution but a time series of reported concentrations. A distribution to me implies a histogram, please correct the naming. Also why did the AQMS report higher PM2.5 concentrations at Berkley, Ogden, Linden and Salt Lake City compared to all the PA-II units during the first half of 2018? Understanding why the relationship changed is important for knowing the parameters that affect the PA-II measurements.

Page 8, line 236: the authors state “These high correlation values and relatively low RMSE indicate that although the PA-II units and the AQMS are not co-located, they still tend to behave in a similar way.” Why do think this was the case?

Page 8, line 242: I do not understand what you mean by instrument efficiency?

Page 8, line 250: why did you subset the data below 40 ug m-3?

Page 12, line 364. In the previous paragraph you state that RH is a more important parameter than temperature when considering potential artefacts for the PA-II, so why compare to temperature?

Page 12. Line 381: I do not agree with this statement as you have not able to test the

precision of the PA-II as they were not co-located. The precision of the PA-II units would be tested by how well each PA unit agree with each other at a given RH, but you have looked for correlation between RH and PA-II reported PM2.5. this does not indicate the precision of the PA-II only if there was a relationship between RH and reported PM2.5 concentrations.

Page 13, line 418: where the slopes between the PA-II and AQMS instruments affected by distance?

Section 3.4: I think that section could be improved by including some recommendations based on your findings from this study.

Page 14, line 433: please call it instrument drift, as instrument efficiency is meaningless in this context.

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