Dear Editor,

Thank you for agreeing to consider a revision of our manuscript "The Aerosol Research Observation Station (AEROS)". We modified and revised the manuscript to address the reviewers' comments as well as to clarify points that they found confusing or unclear.

We would like to thank the two anonymous reviewers for their helpful comments and suggestions, and many thanks to you for your time and efforts with this revision. In line with the comments and suggestions, we revised the manuscript and made the requested additions and changes. Below are all the comments (in bold) followed by the replies. The parts that are in italic are corrections that are included in the revised version of the paper:

Sincerely,
Karin Ardon-Dryer

Anonymous Referee #1
This manuscript describes a new aerosol monitoring station (AEROS) located in West Texas. Three mid-cost instruments (OPS 3330, Grimm-11D and DustTrak DRX) are installed, which provide PM mass concentration, particle number concentration and size distribution. Inter-comparisons and validation of the instruments in the laboratory as well as with atmospheric aerosols are presented. The manuscript is written in a clear language (apart from an issue with the units which is explained below) and the authors describe in adequate detail the monitoring site and facility.

I agree with the authors that mid-cost optical particle size spectrometers, such as the OPS 3330 and Grimm 11-D, seem to perform almost as good as high-end (and therefore more expensive) instruments with regards to particle number concentration and size distribution. I am not so convinced though about the performance of the Grimm 11-D and DustTrak DRX when it comes to PM mass concentration. As the authors correctly highlight, the algorithms used by these instruments are not disclosed. Moreover, calibration of PM monitors in the laboratory is not as standardised yet. In my opinion, mid-cost PM sensors are useful for providing high time-resolution data but there are still open questions about the accuracy of the results. Considering that PM mass concentration is the only regulated metric for aerosols (in most parts of the world), it is important that PM mass concentration is also monitored by the reference (manual) gravimetric method or, at least, by high-end instruments such as Beta Attenuation Mass (BAM) monitor or a Tapered Element Oscillating Microbalance (TEOM). In that sense, I think it is a pity that the manuscript does not provide any reference PM mass concentration data (the filter sampler unit was not operational). This could have increased the overall quality of the manuscript.

We would like to thank the reviewer for the suggestions, corrections, and comments. We agree with the reviewer that a reference unit for PM monitor could have been ideal, but unfortunately such a unit (mainly because of its cost) was unavailable to us at the time and therefore could not be used as part of AEROS. Our filter gravimetric measurements were only available at a later stage, and we are currently working on this comparison.

Based on the reviewer suggestions we added a sentence about the reference PM units to the AEROS limitation section:

The fact that all the instruments used are based on optical size allows for comparison between the instruments, but also mean these instruments require examination and calibration by the manufacturer every year which could be a financial burden as the calibration cost for each unit can range from ~$3000 to ~$5000. While AEROS contain grammatic measurements for $PM_{2.5}$ and PM_{10}, those were not available at the time of this comparison and no access was available to reference units such as Beta Attenuation Mass (BAM) monitor or a Tapered Element Oscillating Microbalance (TEOM), therefore additional measurements under different atmospheric conditions would be required to continue examination Grimm 11-D and DustTrak PM measurements. Another limitation is that our station provides information for only one site and is unable to capture the spatial variability of particles conversation, but even information from this one site is critical for this region, which does not have much information on atmospheric particles number concentrations, different PM sizes mass concentration or and particle size distribution.

Specific comments:

- **I would like to kindly ask the authors to check carefully the units (cm-3 vs m-3) throughout the manuscript. Please make sure that number concentrations are given per cm3 and mass concentrations per m3.**

We would like to thank the reviewer for pointing our attention to this mistake, we apologize it happens. We checked and changed the units throughout the text and figures.

Page 5/Line 148: According to the manual of the 11-D monitor, the number concentration can reach up to 3 000 000 particles/L (= 3 000 particles/cm3, not 3 000 000 particles/cm3 as stated in the manuscript) and mass concentration up to 100 mg/m3 (not 100 000 µg cm-3 as stated in the manuscript). Moreover, the manufacturer has recently revised the online technical specifications of the 11-D monitor to 5 300 000 particles/liter (https://www.grimm-aerosol.com/products-en/dust-monitors/the-dust-decoder/11-d/) (which we have also tested and confirmed in our laboratory).

We would like to thank the reviewer for these corrections, changes were made to the revised manuscript:

Data are recorded at 1 min intervals (it is also possible to save data every 6 s). Particle mass concentration can reach up to 100 mg m^{-3}, while number concentration can reach up to 53,000,000 # L^{-1}.

In Section 3.2 (text), mass concentrations are given in µg/cm-3 where it should have been µg/m-3.Sometimes, number concentration is expressed as #/cm-3 and some other times as #/cc (e.g. in Figure 4B). Please harmonise units throughout the text and figures.

We would like to thank the reviewer for pointing our attention to this mistake, changes were made throughout the text and figures.

Page 5, Lines 118 & 147: the unit of time is "s" (instead of "sec.").

Changes were made according to the reviewer's suggestion.

Page 3, Line 86: Consider revising "liters per min" to "L min-1" to be consistent with the rest of the manuscript.

Changes were made according to the reviewer's suggestion.

- **Figures 3, 6, 7: When referring to particle diameter (x-axis), please specify what type of diameter this is (e.g. mobility, aerodynamic, geometric, optical etc.). In this case, I guess you are referring to optical diameters.**

We added information to the legend of each figure to reflect that the particle size distribution and diameter were based on the optical diameter.

Figure 3. Comparison of the particle size distribution for optical diameter between the OPS and Grimm 11-D…

- **Page 1, Line 21: More precisely, PMx is particulate matter suspended in air which is small enough to pass through a size-selective inlet with a 50 % efficiency cut-off at x µm aerodynamic diameter.**

This information was added to the revised manuscript:
PM is categorized by the size of the particle, with PM_{10} representing a mass of particles with an aerodynamic diameter up to 10 µm. PM_4, $PM_{2.5}$, and PM_1 representing a mass of particles with an aerodynamic diameter of up to 4, 2.5, and 1 µm, respectively. In general, PM measurements define as measurements where 50% of the particles with the defined diameter (e.g., $PM_{2.5}$) will pass through a size-selective inlet.

- **Page 2/Line 54: Consider adding "… provided that they undergo a regular (e.g. yearly) service and recalibration".**

Information suggested by the reviewer was added to the manuscript.

The following information was added to the revised manuscript:
Several studies have found mid-price optical particle sensors to be comparable to high-priced reference units as long as the mid-price optical particle sensors undergo a regular (e.g., yearly) service and re-calibration (Viana et al., 2015; Jaafari et al., 2018; Vasilatou et al., 2021).

- **Throughout the text: The term aerosol concentration or particle concentration is vague. Please consider revising to "particles number concentration" or "particle mass concentration" as appropriate.**

Changes were made throughout the manuscript to reflect when mass or number concentration were used, we left the term particle concentration only when it was general and reflected both mass and number concentration.

An example of such from the revised manuscript:
A comparison of each instrument pair (near each other) showed that both units measured similar overall concentrations (number and mass, data not shown).

- **Page 3/Line 87: I would be interested to know whether the filters are conditioned (in Europe, filters must be conditioned in the weighing room at 19 °C to 21 °C and 45 % RH to 50 % RH for ≥ 48 h according to the standard EN 12341).**

Our filter room condition is based on EPA regulation, which is slightly different than the European one. Our filter room is kept in a room with the condition of temperature in the range of 20-23°C and RH of 30-40%.

We added information about this aspect to the revised manuscript:
Filter are kept in the filter room which follows U.S. EPA (EPA, 1997) regulation conditions of temperature in the range of 20-23 °C and relative humidity in the range of 30-40%. To assure filter weight post sampling will not be impacted by hysteresis effect, filters post-aerosol collections are kept in a Dry-Keeper Auto-Desiccator Cabinet for 48 hours until weight.

- **Page 5/Line 123: Do you mean "to convert the optical DIAMETER to aerodynamic sizes"?**

We thank the reviewer for pointing out this point, this is exactly what we wanted to write, we made changes in the sentence to make it clearer.

… which are needed to convert the particle concentrations which are based on optical diameter to aerodynamic sizes.

- **Page 14/Lines 360 & 376, Figure 7: How can the TOTAL particle number concentration be so low (122 # cm-3) when the number concentration of 0.25-0.3 µm particles is 10^5 # cm-3? Do you mean "total number concentration of particles with optical diameter larger than 1 µm"?**

We would like to thank the reviewer for this comment as it made us realize we plotted in Fig. 7C the raw count values and not the size distribution (dN/dlogDp) values. Corrections were made to Fig.7 and also into the text. Per suggestions from reviewer 2, we also change the figure to colored.

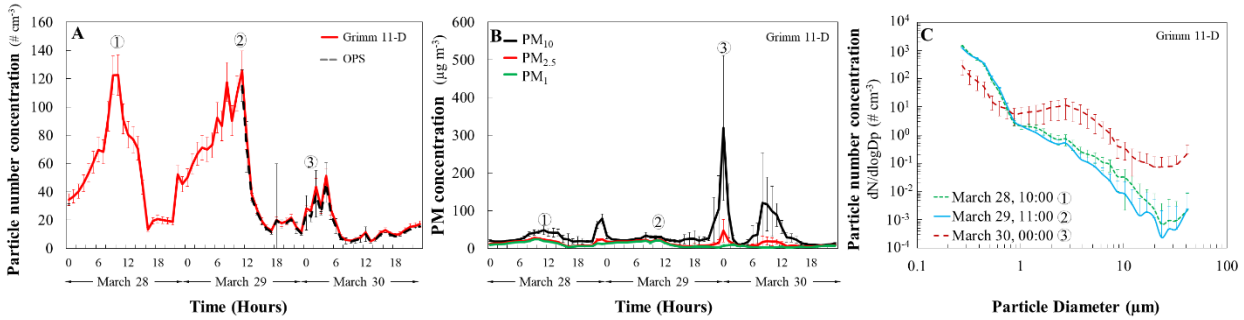

Figure 7. Measurements (hourly average) of total particle number concentration using OPS in black and Grimm 11-D, in red (A), measurements of PM mass concentration from Grimm 11-D (B), and particle size distribution of optical diameter (C) using Grimm 11-D for March 28 - 30, 2019. The numbers on the plots represent different events (1 and 2 for the haze events and 3 for the dust event). Error bars represent SD values of hourly measurements.

- **Page 16/Section 3.5: Please specify how often the instruments undergo maintenance and calibration at the manufacturer or another calibration laboratory. In my experience, light-scattering instruments need to be calibrated on a yearly basis.**

Information about maintenances and calibration was added to section 3.5 per the reviewer's suggestions.

Some of these arise from the maintenance of AEROS, which requires weekly checks and calibrations, including cleaning of the instruments and inlets, and replacement of the silica gel in the dryers. The fact that all the instruments used are based on optical size allows for comparison between the instruments, but also mean these instruments require examination and calibration by the manufacturer every year which could be a financial burden as the calibration cost for each unit can range from ~$3000 to ~$5000.

- **Figures 3 and 6: Please clarify in the caption what the error bars designate. Is it statistical uncertainties and at which confidence interval? Similarly, in Lines 273 and 281, please specify what the measurement uncertainties represent.**

Error bars represent standard deviation values from average for duration measurement represented by the time mentioned in the text. To clarify it we added information to the text and also to the figure caption.

..the PM_{10} particle mass concentration was 0.3 ± 0.16 µg m^{-3} (average ± standard deviation, SD values),

The caption of figure 6 - *Figure 6. Comparison of measurements taken in the AEROS shed with measurements taken on the ground level or on the rooftop floor outside the AEROS shed. (A) Particle size distribution (optical diameter) measured by the Grimm 11-D unit in the AEROS shed (black) and outside on the rooftop floor (light gray). (B) Particle size distribution (optical diameter) measured by the OPS in AEROS (black) and on the ground floor (dark gray). (C) PM concentration at various sizes as measured by the Grimm 11-D unit in AEROS (black) and outside AEROS on the rooftop floor (gray). (D) PM concentration at various sizes as measured by DustTrak in AEROS (black) and on the ground floor (dark gray). Error bars represent SD values of the measured period.*

Minor corrections:
Line 29: consider revising "to monitors…" to "to monitor…"
Changes were made according to the reviewer's suggestion.

Line 46: Consider adding "are", so that it reads "sensors are gaining popularity"
Changes were made according to the reviewer's suggestion.

Line 71: Consider adding a comma after "Texas" so that it reads "Lubbock, Texas, located…."
Changes were made according to the reviewer's suggestion.

Line 185: consider revising "There only reference…" to "The only reference…"
Changes were made according to the reviewer's suggestion.

Line 195: Nowadays, particles are usually made of polystyrene (without latex)
We thank the reviewer for this correction, the word latex was deleted from the sentence.

Line 199: Please provide the location of the company Powder Technology Inc.

Changes were made, we added the location of the company.

For this comparison, Arizona Test Dust (ATD) particles (Nominal 0 - 3 mm, Powder Technology Inc. MN, US)

References used in this document

EPA (1997) Appendix L to part 50—reference method for the determination of fine particulate matter as PM2.5 in the atmosphere. Federal Register 62:57–95.

Jaafari, J., Naddafi, K., Yunesian, M., Nabizadeh, R., Hassanvand, M. S., Ghozikali, M. G., Nazmara, S., Shamsollahi, H. R., and Yaghmaeian, K.: Study of PM10, PM2.5, and PM1 levels in during dust storms and local air pollution events in urban and rural sites in Tehran, Hum. Ecol. Risk Assess.: Int. J., 24, 482-493, https://doi.org/10.1080/10807039.2017.1389608, 2018.

Vasilatou, K., Wälchlia, C., Koust, S., Horender, S., Iida, K., Sakurai, H., Schneider, F., Spielvogel, J., Wu, T. Y., and Auderset, K.: Calibration of optical particle size spectrometers against a primary standard: Counting efficiency profile of the TSI Model 3330 OPS and Grimm 11-D monitor in the particle size range from 300 nm to 10 μm, J. Aerosol Sci., 157, 105818, https://doi.org/10.1016/j.jaerosci.2021.105818, 2021.

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