Response to the referee 2

We thank Amato Evan for his critical assessment of our work and his interesting suggestions that contributed to improve our paper. In the following we address their concerns point by point.

This paper presented results from an observational study designed to evaluate the feasibility of using a so-called low-cost optical particle counter (OPC) to generate high frequency measurements of the size resolved dust concentration, with the specific application to using the eddy covariance method to estimate the vertical turbulent diffusive dust flux. Via comparison with reference instruments, the authors determined that the vertical flux estimated with the low-cost instrument was comparable to that from a (more expensive) reference instrument. I found this manuscript to be thorough in terms of evaluating/comparing the N3's characteristics with the reference OPCs and only have a three comments that I would like to see addressed before I can recommend the manuscript for publication in AMT.

Comments:

Section 2. Can the authors report on the wavelength of light that the three OPCs operate at and how differences in this characteristic may influence the calculated size-resolved particle concentration? I'm specifically thinking about the influence of the (spectrally resolved) particle complex refractive index on the estimated particle sizes (e.g., Huang et al. 2021: Linking the different diameter types of aspherical desert dust indicates that models underestimate coarse dust emission, GRL)

Reply: The N3 utilizes a laser light source, whereas the Promo operates with a xenon source, and the Fidas employs an LED source. The manufacturer does not provide the light source wavelength for the Promo and Fidas. The N3's wavelength ranges from 600 to 650 nm according to *Kaur and Kelly* (2023).
Each of the three OPCs has undergone calibration with monodisperse, non-absorbing polystyrene latex spheres (PSLs). The refractive index is $1.50 + 0i$ for the N3 (default value) and $1.59 + 0i$ for the Promo and Fidas (latex value). The Promo and Fidas underwent calibration at the start of the experiment, whereas the N3 comes pre-calibrated from the factory. Hence, the three OPCs consider spherical particles with size corresponding to optical diameters, and provide particle size distributions in terms of PSL-equivalent diameters, producing the same scattered light intensity as the measured (absorbing and irregular) dust particles, but at a different wavelength range depending on the OPC.
Since the three OPCs have been calibrated using the same particles, we assume that the calibrations of the N3 and Promo relative to the Fidas, as described in section 3.3, inherently account for differences in optical diameters due to different wavelengths of each instrument, along with other factors like the inlet design. Given this calibration, we propose that the conversion of N3 particle size distributions (PSDs) to dust geometric diameters, following *Huang et al.* (2021), may use the same conversion as the reference instrument, *i.e.*, the Fidas.
This discussion has been incorporated into the manuscript.

Section 3.1 Can/should the apparent tendency of the N3 OPC to misclassify 1 um particles into the 1.4 um bin be accounted for by summing the particle counts for these two bins? This could also help to address the related bias shown in Fig 14b at these same sizes.

Reply: This may indeed serve as a solution; however, it would diminish the size resolution of the N3 dust concentration, which is already coarse in comparison to the Promo within this size range. Regarding

this comment, this tendency of the N3 OPC to misclassify 1 μm particles into the 1.4 μm bin should not affect the $PM_{2.5}$ and PM_{10} estimations.

Section 3.2 I am afraid I don't understand why the reduction in the N3 flow rate results in an overestimation of the N3 concentration relative to the Promo, given that the N3 flow rate is accounted for in the concentration calculation (line 91). Can the authors provide an explanation why accounting for the flow rate in the concentration calculation is nonetheless insufficient to account for the wind direction bias?

Reply: This is a good point for which we do not have an explanation. The only issue we anticipated with the decrease in the N3 flow rate is that air sampled at 1 Hz may be less representative of the ambient air, potentially causing problems for low concentrations, probably underestimating the concentration but not overestimating it. The correlation between the reduction of the N3 flow rate and the overestimation of particle concentration may suggest either an underestimation of the flow rate by the sensor or the existence of an unknown calibration factor somewhere hard-coded in the N3, and linked to the N3 average flow rate.

References

Huang, Y., A. A. Adebiyi, P. Formenti, and J. F. Kok, Linking the different diameter types of aspherical desert dust indicates that models underestimate coarse dust emission, *Geophysical Research Letters*, *48*(6), doi:10.1029/2020gl092054, 2021.

Kaur, K., and K. E. Kelly, Performance evaluation of the alphasense opc-n3 and plantower pms5003 sensor in measuring dust events in the salt lake valley, utah, *Atmospheric Measurement Techniques*, *16*(10), 2455–2470, doi:10.5194/amt-16-2455-2023, 2023.