Response to interactive comments from Referee #2

Thank you for the time you put into reviewing our manuscript and the helpful feedback. Please find below our responses and proposed changes to the original manuscript, which improve the manuscript. Below the comments from Referee #2 are given in black. Our responses to the comments are shown in blue. Text added or changed in the manuscript is marked in italics.

The manuscript presents an interesting application of a heater/dryer to lessen the impact of high humidity/fog events on OPC performance. The experiments are carefully executed and clearly described. There are no major problems with the text or content, other than a general lack of statistical analysis (correlation, deviation, statistical significance etc).

Thank you for the assessment of our work. In order to cover the lack of statistical analysis we have added the errors calculated with the standard deviation of the drying efficiencies. Moreover, we have included field measurements to compare the OPC-R1 with low-cost dryer to gravimetric analysis and a "reference-equivalent" monitor under real conditions. The results include three new tables with a summary of statistics (SD, MAE, RMSE, MBE, slope, offset, R^2 and Pearson coefficient).

However, I remain unconvinced of the arguments given that this hardware solution to the problem is merited over software solutions, which are presented as complex and difficult. It is acknowledged in the paper that calibration of the OPC is still required. Software solutions are theoretically capable of addressing several limitations of OPCs, including high humidity, variation in composition, size distribution etc. This hardware solution only addresses one, so I would argue that software solutions of a similar complexity will still be required even in units with a dryer fitted.

As we have described in the introduction, all currently available solutions to avoid the negative effect of high RH on sensor readings, hardware as well as software ones, have advantages and disadvantages. As the reviewer states, software solutions are theoretically capable of addressing several limitations of OPCs, but they do have limitations too. These limitations have already been described in the original manuscript in lines 67 to 78.

We can argue that neither the low-cost dryer nor the software solution will make the sensor to be exempted of calibration. Calibration is always needed, even for traditional air quality monitors and reference instruments. The advantage of using a dryer would be to calibrate/correct the sensors signal against a reference instrument with a univariate linear regression without the additional need of a software. This is in our opinion a more citizen-friendly/Do-It-Yourself method than a software solution.

In order to address these points in the manuscript, we have added the following text:

"It is worth noting that even though drying the air could arise questions about how the temperature affects the physico-chemical properties of the particulate matter, existing software solutions are not problem-free, as they may fail when changes in the particle chemical composition occurs. Moreover, a software solution that helps to minimize the effect of the hygroscopic growth and fog events in the mass concentrations has not been reported in the literature. In general, the effect of fog in the mass concentrations of sensors has scarcely been addressed in the literature."

Furthermore, dryers introduce problems of their own, notably the driving off of semivolatile PM. The authors acknowledge this but do not propose a solution, just advising a compromise. This compromise may negate the benefit of the hardware solution over existing software solutions. These two facts together suggest that a dryer is an incomplete solution that will increase hardware cost and complexity but not necessarily decrease the need for software correction except, perhaps, in very specific high frequency foggy geography. The authors are welcome to attempt to address these points to make a more convincing argument as to the utility of a dryer.

We admit that our dryer may introduce problems of its own but, as explained in the manuscript, software solutions are not the "holy grail" either. Our prototype may not be the perfect solution but can be a source of inspiration for other researchers to improve it, or it could be combined with software solutions.

We have added the following text:

"It is clear that PM sensors have come to the air quality monitoring market to stay, and that (i) all new approaches (hardware, software or hybrid-solutions) which aim to improve the accuracy of PM sensors and (ii)

evaluations on how they behave when the environmental conditions change due to e.g. fog events, long-range transport, or a change in sensor location, are welcome to be addressed in future research."

Other points:

Abstract - The abstract does not describe the results well - lower PM2.5 concentration in itself does not equate to improved sensor performance or accuracy. Statistics should relate to statistical comparison with reference method results.

We have included a statistical analysis comparing the results of the low-cost dryer with the standard method. Moreover, we have substantially modified the abstract to read as follows:

"The use of low-cost sensors for air quality measurements has become very popular in the last decades. Due to the detrimental effects of particulate matter (PM) on human health, PM sensors like photometers and optical particle counters (OPC) are widespread and have been widely investigated. The negative effects of high relative humidity (RH) and fog events in the mass concentration readings of these types of sensors are well documented. In the literature, different solutions to these problems - like correction models based on the Köhler theory or machine learning algorithms - have been applied. In this work, an air pre-conditioning method based on a low-cost, thermal dryer for a low-cost OPC is presented. This study was done in two parts. The first part of the study was conducted in laboratory to test the low-cost dryer under two different scenarios. In one scenario, the drying efficiency of the low-cost dryer was investigated in the presence of fog. In the second scenario, experiments with hygroscopic aerosols were done to determine to which extent the low-cost dryer reverts the growth of hygroscopic particles. In the second part of the study, the PM10 and PM2.5 mass concentrations of an OPC with dryer were compared to gravimetric measurements and a continuous Federal Equivalent Method (FEM) instrument in the field. The feasibility of using univariate linear regression (ULR) to correct the PM data of an OPC with dryer during field measurement was also evaluated. Finally, comparison measurements between an OPC with dryer, an OPC without dryer and a FEM instrument during a real fog event are also presented. The laboratory results show that the sensor with the low-cost dryer at its inlet measured an average of 64 % and 59 % less PM2.5 concentration compared to a sensor without the low-cost dryer during the experiments with fog and with hygroscopic particles, respectively. The outcomes of the PM2.5 concentrations of the low-cost sensor with dryer in laboratory conditions reveals, however, an excess of heating compared to the FEM instrument. This excess of heating is also demonstrated in a more in-depth study on the temperature profile inside the dryer. The correction of the PM10 concentrations of the sensor with dryer during field measurements by using ULR showed a reduction of the maximum absolute error (MAE) from 4.3 µg m^{-3} (raw data) to 2.4 µg m^{-3} (after correction). The results for PM2.5 make evident an increase in the MAE after correction: from 1.9 µg m^{-3} in the raw data to 3.2 µg m^{-3}. In light of these results, a low-cost, thermal dryer could be a cost-effective add-on that could revert the effect of the hygroscopic growth and the fog in the PM readings. However, special care is needed when designing a low-cost dryer for a PM sensor to produce FEM similar PM readings, as high temperatures may irreversibly change the sampled air by evaporating the most volatile particulate species and thus deliver underestimated PM readings. New versions of a low-cost dryer aiming at FEM measurements should focus on maintaining the RH at the sensor inlet at 50 %, and avoid reaching temperatures higher than 40 °C in the drying system. Finally, we believe that low-cost dryers have a very promising future for the application of sensors in citizen science, in sensor networks for supplemental monitoring, and for epidemiological studies."

Introduction - the example shown focuses the discussion on PM10, yet the publication focuses on PM2.5. Rewrite text with focus on PM2.5 as OPC have other issues not addressed when sampling PM10.

In the new results for field measurements, we have included PM10 as well as PM2.5. Moreover, we believe it is important to clarify the particle size distribution of fog even though in the laboratory experiments only the PM2.5 are presented. Nevertheless, we have added a new sentence in the introduction.

"PM2.5 and PM1 are in the range of $10^2 – 10^3$ and $10^1 – 10^2$ µg m-³, respectively."