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Model Evaluation of Optical Counter Derived PM2.5 Concentrations with a Beta Attenuation Monitor (BAM) data in Nairobi, Kenya

Introduction

Particulate matter (PM2.5) is known to have adverse health effects on human health and to impact on climate. For human health concerns the type of involved measuring instruments are expensive and in the low- and middle- income countries (LMICs), they are very few thus inhibiting implementation of dedicated studies. Well calibrated OPCs can offer indicative PM2.5 data that can be used in modelling ground concentrations and reverse the perennial paucity of data in LMICs. This report is from a short study carried out in Nairobi, Kenya, using AlphaSense optical counters (OPC-N2).

Methodology

Five OPC-N2 were collocated with a BAM-1020 at the top of the Engineering Building, University of Nairobi, about 20 m above ground level. They were placed a few feet from each other to ensure free flow of air (Pope et al., 2018). Simultaneous measurements were carried out for one month (September 2021) and weather data was retrieved from an AlO 2 Sonic weather sensor at the same site. The data from the OPCs was compared with the BAM data by employing two linear regression models and three machine learning techniques.

Results

Generally, similar patterns of concentrations were observed (Fig. 1). However, the OPCs data was much lower than the BAM data, highlighting the inferior measurement technique in OPCs.

The plots suggest the existence of two profiles one at low humidity and the other at high humidity (Fig. 2). At high relative humidity the lower concentrations of PM2.5 from the OPCs correlate more with the higher concentrations from the BAM (Crilley et al., 2018).

Table 1: Performance of different models used to calibrate Alphasense OPC-N2s

The best performing models for most OPCs were the machine learning techniques with the kNN model showing the highest R2 value and lowest MAE and RMSE for three of the sensors (see Table 1). Different calibration models were developed for each of the OPC as opposed to an average approach or using one model for all (Báthory et al., 2022; Magi et al., 2020).

Conclusion and Recommendations

The multilinear regression, the random forest, k nearest neighbor and the gradient boost models account for the influence of meteorological conditions on the PM2.5 measurements and result in

better agreement between sensor and reference grade monitors than simple linear regression model.
Future studies should use a longer calibration period that covers all seasons to improve understanding the influence of meteorological variables on OPCs. Although this is well documented in literature machine learning modelling approach has not been used for calibration in Nairobi.
Calibrated OPCs will help in mining particulate data where it is scanty or does not exist.

References

Crilley et al. (2018). J. Atmospheric Measurement Techniques, 709-720.
Pope et al. (2018). J. Atmospheric Chemistry and Physics, 18(20), 15403-15418.
Báthory, C., Dobó, Z., Garami, A., Palotás, Á., & Tóth, P. (2022). Journal of Environmental Management, 304, 114158.
Magi, B. I., Cupini, C., Francis, J., Green, M., & Hauser, C. (2020). Aerosol Science and Technology, 54(2), 147–159.

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