Non-Linear Correction Methods Applied to Long Term Deployment of Low-Cost Air Quality Sensors

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Combustion generated particulate matter and gases impact local air quality. “Low-cost air” quality sensor suites introduced commercially in the past ten years have promised to allow significant increases in spatial resolution of sensing networks to improve source apportionment. The Minnesota Pollution Control Agency (MPCA) has deployed a network of 50 AQ-Mesh sensors around the Minneapolis-St. Paul Metro Area. The sensor suite includes electrochemical sensors for nitrogen monoxide (NO), nitrogen dioxide (NO2), carbon monoxide (CO), and ozone (O3). The suite also has an Alphasense OPC-N2 particle counter for PM measurements, along with temperature, pressure, and relative humidity sensors. The deployment of the sensors has lasted two years, much longer than other large-scale deployments. This work examines the quality of the measurements and focuses on using corrective models to improve the quality of the measurements to be used in further work.

A correlation analysis was conducted at sites where a low-cost AQ-Mesh sensor suite was collocated with a suite of federal equivalent method sensors to determine which features and the most predictive power individually. Then those features were used to create a predictor that analyzed the data and made corrections. The predictors were three types, Random Forests (RF) and Neural Networks (NN), and a common correction method, linear regression. There were two general sets of data used to train predictors; the first was the sensors collocated at FEM sites during the whole deployment period of two years. The second set of predictors were built from mass colocations before and after the two-year deployment. The corrections were tested against the data from the long-term colocation sites.

The results show a reduced relative error of the sensors for all predictors meaning that the correction models improve the accuracy of the sensors. However, the RF and NN corrections showed a reduced linear correlation between the AQ-Mesh Sensor output and a Federal Equivalent Method (FEM).