Development of an environmental chamber for evaluating the performance of low-cost air quality sensors under controlled conditions

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ABSTRACT

A state-of-the-art integrated chamber system has been developed for evaluating the performance of low-cost air quality sensors. The system contains two professional grade chamber enclosures. A 1.3 m^3 stainless-steel outer chamber and a 0.11 m^3 Teflon-coated stainless-steel inner chamber are used to create controlled aerosol and gaseous atmospheres, respectively. Both chambers are temperature and relative humidity controlled with capability to generate a wide range of environmental conditions. The system is equipped with an integrated zero-air system, an ozone and two aerosol generation systems, a dynamic dilution calibrator, certified gas cylinders, an array of Federal Reference Method (FRM), Federal Equivalent Method (FEM), and Best Available Technology (BAT) reference instruments and an automated control and sequencing software. Our experiments have demonstrated that the chamber system is capable of generating stable and reproducible aerosol and gas concentrations at low, medium, and high levels. This paper discusses the development of the chamber system along with the methods used to quantitatively evaluate sensor performance. Considering that a significant number of academic and research institutions, government agencies, public and private institutions, and individuals are becoming interested in developing and using low-cost air quality sensors, it is important to standardize the procedures used to evaluate their performance. The information discussed herein provides a roadmap for entities who are interested in characterizing air quality sensors in a rigorous, systematic and reproducible manner.

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