
Laboratory performance evaluation of air quality low cost sensors

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Abstract

- SUMMARY:

Low-cost sensors have been increasingly used to monitor air quality. However, these sensors are often not properly evaluated and performances can vary from one sensor to another. Considering this crucial need in sensor evaluation, LNE developed an exposure chamber for evaluating the performances of air quality low cost sensors. Stable and reproducible aerosol and gas concentrations/molar fractions are generated at several levels in a well-controlled range of temperature and relative humidity. The low cost sensors are directly installed in the exposure chamber and their evaluation relies on the comparison between sensor and reference measurements. Furthermore, in order to standardize the procedures used to evaluate air quality sensors performances and to reduce confusion on the marketplace (by giving clear and comparable evaluation criteria), a voluntary certification for air quality low cost sensors was created in France in early 2019 by LNE and INERIS.

- MOTIVATION and RESULTS:

Due to their low cost and ability to provide data with high temporal resolution, low cost sensors are increasingly used to monitor air quality [1,2]. The panel of users for these sensors is large and extensive, including academic and research institutions, government agencies, public and private institutions and civil society. These sensors can be used, for instance, for citizen science campaigns, personal exposure estimation or school science programs.

In order to ensure their appropriate use and the sufficient data quality depending upon its application, there is a crucial need to evaluate metrologically the reliability and performances of these sensors.

In this context, an exposure chamber was developed at LNE (French national metrology institute) for evaluating the performances of air quality low cost sensors (Figure 1) by generating controlled aerosol and gaseous atmospheres. In order to work in a wide range of environmental conditions, the chamber is also temperature and relative humidity controlled. Generation systems for gas and aerosol (by wet and dry processes) and a panel of reference instruments are implemented in the experimental set-up. As a result, this chamber system is capable of generating stable and reproducible aerosol concentrations and gas amount fractions at several levels in a well-controlled range of temperature and relative humidity. The

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low cost sensors to be tested are directly installed in the exposure chamber and their evaluation relies on the comparison between sensor and reference measurements. Among the tested parameter, accuracy, linearity, limit of detection and repeatability are evaluated. Effects of relative humidity and temperature on sensor responses are also investigated.

Furthermore, in order to standardize the procedures used to evaluate air quality low cost sensors performances and to reduce confusion on the marketplace (by giving clear and comparable evaluation criteria), a voluntary certification for air quality low cost sensors was created in France in early 2019 by LNE and INERIS. This new certification consists in a field and laboratory performance evaluation and is dedicated to low cost sensors capable of measuring particulate matter (PM_{2.5}) and nitrogen dioxide (NO₂) in a first step.

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References:

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FIGURE:

Figure 1. Experimental set-up description of the air quality low cost sensor exposure chamber

Keywords: low cost sensor, air quality, aerosol, gas, air pollutant