Multi-sensors devices to monitor urban air quality as a support for the official network: development, selection and calibration

C. Falzone[1], F. Lenartz[2] & AC. Romain[1]

[1] Sensing of Atmospheres and monitoring (SAM), University of Liege (ULiege), Arlon Campus Environment, Avenue de Longwy 185, 6700 ARLON, Belgium
cfalzone@uliege.be, acromain@uliege.be
[2] ISSeP, Rue du Chéra 200, 4000 Liège, Belgium
f.lenartz@issep.be

Abstract

Measurements at the official network air quality measurement stations are carried out using expensive technologies, making it difficult to multiply the number of stations required for local monitoring. To remedy this situation, instruments based on low-cost sensors (LCS) are increasingly being considered for air quality studies in pollution niches. These devices generally include electrochemical sensors for gaseous pollutants such as NO, NO_2, O_3, SO_2 and CO, a photoionization detector for volatile organic compounds, and an optical sensor for measuring fine particle concentrations [1].

The aim of this study is to compare and classify (following table 3 from CEN/TS 17660 [2])the various sensors available on the market for monitoring urban air quality. The accuracy of the sensors, after calibration with a reference station, will be analysed in order to identify the best sensors for this application. In addition, by exposing the sensors to urban air over a long period, we will be able to correct their drift using machine learning [3].

Several such LCS systems have been developed in our laboratories to monitor the concentrations of pollutants. Different sensor trademark are considered and compared in order to determine the best LCS combination (table1). In addition to usual gas sensors, micro-sensors as metal oxides are also used. Physicochemical analysers are used as the references. SAM and ISSeP have teamed up for this study.

Table 1. Sensors brand selection and references devices

Pollutants	SAM	ISSeP	References
CO	Alphasense®, Winsen® ,SGX®	Alphasense®, Sensorix®	
CO_2	Winsen®	Sensirion®	
COV		-	
CH_2O	Winsen®	B-Sens®	
NH_3	SGX®	Sensorix®	
NO	Alphasense®	Alphasense®	APNA 370 HORIBA®
NO_2	Alphasense®, Winsen® ,SGX®	Alphasense®	APNA 370 HORIBA®
O_3	Alphasense®, Winsen® ,SGX®	Alphasense®	APOA 370 HORIBA®
$PM_{2.5}$	Sensirion®, Winsen®	Sensirion®, Plantower®	EDM180 GRIMM®

The devices are installed side-by-side on top of the Herstal reference station in Belgium (Lat-50.66, Long-5.63). This urban background station comprises various reference instruments for the monitoring of BC, NO, NO_2, NO_x, O_3, PM_{10}, $PM_{2.5}$ and COV (https://www.wallonair.be).

Field calibration of the various sensors in relation to the analysers is carried out using different methods. Firstly, calibration methods including or excluding some of the potential interferents are compared to obtain the best response from the sensors in relation to the reference value. Secondly, the direct normalization method (calibration transfer) is applied to recalibrate and compensate for natural sensor drift [4].

References

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