Determination of the UFP_3031 Uncertainty on Number Concentration regarding Ambient Air Particle Monitoring

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From 2011 onwards, some French regional air quality monitoring networks started to develop strategies for the monitoring of airborne ultraFine particles.

To ensure the consistency of the results obtained from these various programs, a single measurement technique has been commonly selected, the Model 3031 Ultrafine Particle (UFP) Monitor.

Objective of the study

Two interlaboratory exercises have been organized in 2014 and 2015, to assess the accuracy of the instrument through a comparison with other techniques (such as Scanning Mobility Particle Sizer, SMPS), and through uncertainty calculations.

Instrumentation

The UFP 3031 is manufactured by TOPAS and commercialized by TSI. It measures the size distribution and number concentration within six particle size classes between 20 and 800 nm. The principle is based on diffusion charging of particles, followed by size segregation within a Differential Mobility Analyzer (DMA) and detection of the aerosol via an electrometer. It has been specifically designed for long-term, air quality monitoring networks. It operates with minimal maintenance, requires no working fluids and has no radioactive source. It is easily installed into existing air quality monitoring stations.

Method

All instruments have been carried out in an urban air monitoring station at Creil (60).

	2014	2015
Nb. of instruments	6	5 (+1)
Nb. of laboratories	4	3 (+1)
Period	9-20 July	16-29 June
Nb. hourly data validated	261	310
Nb. conc. range ($p.cm^{-3}$)	5,600–18,000	1,200-23,000

Table 1. Information regarding exercises.

They were equipped with an individual sampling line provided by TSI, including a PM10 ambient air sampling head and a PM1.0 cyclone. A commercial SMPS (DMA-3080 + CPC-3775 TSI) has been implemented with 5 min scanning. Table 1 reports the main characteristics of the two exercices.

Results for the 200 – 800 nm channel

The comparison of data regarding the 200 – 800 nm channel shows some limitations. For instance, the average relative uncertainty calculated (cf. below) in 2015 has been of 90%. This could be due to the low concentration in the environment in that range, regarding the detection limit of the system (electrometer). As a consequence, data obtained for this channel should be considered only as indicative.

Results for the 20 - 200 nm range

Each instrument could be systematically compared to a commercial SMPS using orthogonal regressions, for each of the 5 channels of the 20 - 200 nm range, and satisfactory results have generally been obtained. For instance, more than 85% of the calculated coefficient director are in the 0.70 – 1.30 range, and more than 80% of the correlation coefficients (r^2) are over 0.90.

The 3031 datasets have been evaluated using a Grubb test, before uncertainty calculations (intra-technique). Uncertainty has been calculated at 6 concentrations, for each channel, and for the total concentration.

Finally, in 2015, the average relative uncertainty ranged from 13 % (70 – 100 nm) to 25 % (30 – 50 nm).

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