EMPIR Call 2019 – Energy, Environment, Normative and Research Potential

Selected Research Topic number: **SRT-v05**
Version: 1.0

Title: Advanced Aerosol Metrology for Atmospheric Science and Air Quality

Abstract

Air pollution is a key environmental and social issue and is a complex metrology challenge in terms of management and mitigation of harmful pollutants. Air pollutants are emitted from anthropogenic and natural sources and are among the most important environment-related health concerns. Accurate measurements of aerosols are a major problem for enforcing regulations, protecting human health, determining their effects on climate change and understanding atmospheric processes. European air quality networks can be strengthened by including portable instruments in field applications to improve the data reliability. Necessary methodological improvements and innovations of dimensional and analytical aerosol metrology will be introduced.

Keywords

lab-based calibration, portable instruments, pollen monitoring, reference materials for pollutants analysis, TXRF, particulate matter (PM), chemical composition, air quality networks, MPSS, ICP-MS

Background to the Metrological Challenges

More than 100 million Europeans suffer from allergic rhinitis and 70 million from asthma, with estimated annual costs in the EU region of 10 to 150 billion euro. Accurate pollen monitoring is necessary to prevent, diagnose and treat pollen allergy and to underpin the efforts in R&D of new therapies. Over the past decade the concentrations of several regulated particulate-based air pollutants have shown decreasing trends. Therefore, monitoring air pollution remains an important task even under these conditions, to demonstrate ongoing compliance with EU Air Quality Directives, to monitor the exposure and assess the impacts of point or diffuse emissions sources.

For the first time the European metrological service network has launched the EUMETNET Auto Pollen Programme – an automatic pollen monitoring network for the real time measurement of the number concentration of airborne pollen particles and the identification of their taxa. This was set up to provide reliable calibration methods and quality assurance procedures however, this poses a challenge for aerosol elemental quantitative analysis due to sensitivity, size-selective cascade impactor sampling (CIS) in combination with mobile total-reflection X-ray fluorescence analysis (TXRF) and time resolved in-situ method for the quantification of heavy metals and other elements in ambient air, especially at low particulate pollutant concentrations. Furthermore, mercury levels in ambient air are not currently regulated under EU although Directive 2004/107/EC describes mercury as ‘a very hazardous substance for human health and the environment’. Thus, the need to develop an improved method for the detection of Hg in ambient air. The development of reference samples based on certified and well characterised materials is vital for the traceability and reproducibility of sampling in combination with the TXRF method.

Currently, the counting of pollen particles and identification of their taxa relies on manual methods, i.e. collection of pollen on suitable substrates and inspection with a microscope. These methods provide poor time resolution. Automatic pollen monitoring instruments provide real-time measurements, suited for unattended operation and providing denser spatial coverage with lower running costs. The measurement accuracy and reproducibility of these instruments are unknown, since appropriate reference aerosols or calibration methods do not yet exist. An accurate online and real-time measurement of pollen number concentration in the air together with an identification of the correct pollen taxa will help to prevent and diagnose pollen allergy on a European level and will underpin academic research in developing new therapeutic methods and treatments for pollen allergy.

The usefulness of aerosol particle size spectrometers such as mobility, optical and aerodynamic particles size spectrometers (MPSS, OPSS, and APSS) in atmospheric research, depends on the ability to properly ensure

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the performance of the entire system but also of their components. The traceability of OPSS and APSS number concentrations, especially for the range from 1 µm to 10 µm is seen as a challenge. Intercomparison activities in the frame of ACTRIS among commercial optical and aerodynamic particle size spectrometers show systematic deviations of up to one order of magnitude in particle number concentration. Therefore, improvements of the equivalency between gravimetric and PM mass concentration measurement with OPSS and APSS are necessary. The improvements to monitor air quality particle mass concentration will provide data that are more reliable and have an effect on the measurements within the European research infrastructure ACTRIS as well as related to ISO 15900.

Furthermore, qualification of portable commercial instruments for coherent response behaviour under well-controlled laboratory conditions and varying environmental conditions is crucial to ensure their appropriate use and to avoid the risk of misinterpreted results. The temporal and spatial resolution of aerosol particle measurements is a challenge in terms of air quality on ground, and in exposure population studies. Lightweight and portable particle instrumentation measuring aerosol particle concentration in number and mass are needed.

Significant improvements to air quality by validating new measurements procedures and reducing measurement uncertainties for key particulate pollutants and bioaerosols will ensure that international data are more reliable, reproducible and with improved comparability. European aerosol instrument manufacturers will also benefit from these improvements. Furthermore, it will be useful for the future CEN technical specification on performance evaluation of sensors for the determination of concentrations of particulate matter in ambient air (CEN/TC 264/WG 42). Policy makers and air quality managers at European level will benefit from the establishment of standards and recommendations for a proper use of portable ambient aerosol particle instruments. This will contribute to achieve the objective of European air quality improvement by increasing knowledge on air pollution.

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on the traceable measurement and characterisation of aerosol in the environment.

The specific objectives are

1. Using test aerosol particles in test chambers, to develop traceable methods for the calibration of optical and aerodynamic particle size spectrometers to determine mass and number concentration, as well as size distribution. In addition to characterise aerosol bipolar charge conditioners in mobility particle size spectrometers and based on this the pre-normative definition of their performance criteria.
2. To develop new calibration procedures for automatic pollen monitoring instruments based on fluorescent polystyrene latex and real pollen particles (at concentrations < 1/cm^3, and particle sizes of 0.5 µm up to > 20 µm, with target uncertainties of < 10 %). In addition, comparisons to reference instruments in the field will be used to characterise instrument responses to pollen.
3. To develop certified reference substrates and traceable measurement techniques for the quantification of regulated and unregulated substances in ambient air with cascade impactor sampling and x-ray fluorescence analysis (XRF).
4. To develop portable instruments and software applicable for the measurement of ambient aerosol particle concentrations under variable environmental conditions. Knowledge gained is to be applied to other appropriate classes of portable instruments by the production of suitably adapted procedures.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by: the measurement supply chain (accredited laboratories), by standards developing organisations (ISO and CEN) and end users (e.g. the Network of European Air Quality Reference Laboratories, the European Monitoring and Evaluation Programme, the European Research Infrastructure (Aerosol, Clouds and Trace Gases Infrastructure) and its future European Research Infrastructure Consortium ERIC).

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. To enhance the impact of the research, the involvement of the appropriate user community such as industry, standardisation and regulatory bodies is strongly recommended, both prior to and during methodology development.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.0 M€, and has defined an upper limit of 2.3 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 35 % of the total EU Contribution across all selected projects in this TP.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the Environment sector.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically, the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work.

Time-scale

The project should be of up to 3 years duration.

Additional information

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1] M/503 Standardization mandate to CEN, CENELEC and ETSI in support of the implementation of the ambient air quality legislation