EMPIR Call 2015 – Health, SI, Normative and Research Potential

Selected Research Topic number: **SRT-n06**
Version: 1.0

Title: Black Carbon and Total Carbon measurements in air

Abstract

The optical absorption metric for airborne particles known as black carbon (BC) is important both for its direct role in climate change and as a measure of soot-like combustion products associated with health effects. In the latter role it is a promising candidate for regulation as it is easily measured, and the effect of actions to reduce emissions is soon evident, unlike with other particle metrics such as $PM_{2.5}$. Total Carbon (TC) is a related parameter based on thermo-chemical analysis. Neither metric has fully standardised methods, traceability, or properly understood uncertainty. This SRT calls for proposals to address these metrological issues with the aim of bringing the metrics to a stage suitable for standardisation within CEN.

Keywords

Black carbon; soot; elemental carbon; organic carbon; total carbon; air pollution; vehicle emissions; combustion products

Background to the Metrological Challenges

Measuring air pollution by assessing the darkness of particulate pollution sampled onto a filter has a long history, starting with the Black Smoke Index that was used in the United Kingdom and elsewhere from the 1920s. The technique has progressed in terms of the methods used to quantify the optical absorption, and of the assumptions made when converting the measured absorption into a pollutant concentration (typically in $\mu g/m^3$). The composition and optical properties of soot-like pollution changes markedly as combustion sources change from coal burning to vehicle exhausts, for example, with significant changes to the relation between light absorption and mass concentration. Contemporary measurements using the Black Smoke method give mass concentrations about 4 times greater than modern black carbon measurements.

There are currently no analytical methods that lead to consistent and accurate determination of the soot content in atmospheric particles. Light absorption may be determined from various methods, among them filter-based techniques (by far the most widely used), which require complex (and still questionable) data inversions. Furthermore, there is currently no way of calibrating aerosol absorption data obtained from filter-based instruments in a metrologically-acceptable manner. Moreover, these instruments provide users with "black carbon" concentrations, expressed in $\mu g/m^3$, designed to be equivalent to Elemental Carbon, determined as a split of the Total Carbon into Elemental Carbon (EC) and Organic Carbon (OC). The black carbon values are derived from the light attenuation measurements using empirical conversion factors. An operational definition of EC and OC is currently being finalised by CEN/TC 264 WG 35.

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 development of traceable measurement methods for use in the standards proposed for development within CEN TC 264.

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The specific objectives are

1. To provide a substantial contribution to the development of standards within CEN/TC 264 WG 35 relating to black carbon. The contribution is to be focused on:
   a. traceable measurement and calibration methods for light absorption by particulate matter sampled on filters;
   b. rationalised methods for converting light absorption measurements to black carbon concentrations based on better understanding of filter characteristics, filter loading effects etc., together with uncertainty estimations;
   c. quantified relationships between black carbon and Elemental Carbon.
2. To provide a substantial contribution to the development of standards within CEN/TC 264 WG 35 relating to Total Carbon. The contribution is to be focused on optimised traceability mechanisms with quantified uncertainty, and calibration methods, together with investigation into factors affecting the thermo-optical analysis, feeding back into refinement of the methods for Elemental Carbon and Organic Carbon.
3. To contribute to the standards development work of the key European and International Standards Developing Organisations to ensure that the outputs of the project are aligned with their needs, communicated quickly to those developing the standards and to those who will use them, and in a form that can be incorporated into the standards at the earliest opportunity.

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Standards Developing Organisation or by a letter signed by the convenor of the respective TC/WG. EURAMET encourages proposals that include representatives from industry, regulators and standardisation bodies actively participating in the projects.

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 0.4 M€, and has defined an upper limit of 0.5 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project. Any deviation from this must be justified.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

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 environmental sector.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing a Joint Research Project”

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

This topic is in response to needs identified by CEN/CENELEC published at http://msu.euramet.org/pre_norm_2015/index.html#stage1-orientation (priority 8: Black carbon (BC) and total carbon (TC) measurements in ambient air).