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

Selected Research Topic number: **SRT-v01**
Version: 1.0

Title: Metrology for climate relevant volatile organic compounds

Abstract

Climate change poses high impact risks to society. Long-term, accurate, worldwide measurements of volatile organic compounds (VOCs) are pivotal to understanding changes in the Earth's climate and to addressing the effects of climate change. Dependent on molecular composition, VOCs can influence the oxidising capacity of the atmosphere, the lifetime of methane, ozone and aerosol formation and radiative forcing. As the abundance of atmospheric VOCs is low (parts-per-trillion to parts-per-billion) with some components being reactive, these pose challenges in sampling, analysis and calibration. The availability of high-quality reference materials is essential to reach the necessary accuracy, as expressed in the WMO data quality objectives.

Keywords

Volatile organic compounds, oxy-VOCs, halogenated compounds, monoterpenes, reference gas mixtures, surface interactions, sampling methods, traceability, field measurements, climate change

Background to the Metrological Challenges

Volatile organic compounds, in particular those containing heteroatom species, e.g., oxygen, nitrogen and halogens, cover a broad category of compounds present in the atmosphere. They play a critical role in the major aspects of atmospheric chemistry: air quality, oxidation capacity of the atmosphere, stratospheric chemistry and ozone depletion, climate understanding and finally global assessment of long-range transport of substances emitted into the atmosphere. VOCs are of significant interest for health, environment and science. The WMO/GCOS (Global Climate Observing System) designated them as "Essential Climate Variable" under the categories "aerosols precursors" (= oxygenated VOCs and monoterpenes) and "greenhouse gases" (= halogenated compounds).

Atmospheric concentrations are in the range of pmol/mol to nmol/mol for the monoterpenes to tens of nmol/mol for oxygenated VOCs. The halogenated compounds contain fluoro and/or chloro atoms. They are in the atmosphere at pmol/mol amounts fractions. They arise from anthropogenic emissions and they are direct greenhouse gases with a high global warming potential (GWP) (up to ~20000 GWP). These compounds are of great interest in air quality and climate change because of their impact on human health and environment and their influence in ozone and aerosols formation. Thus, the demand for accurate long-term observations of these VOCs to address the effect of climate change, to assess the trends in the chemistry of the atmosphere and to control the air quality. Furthermore, policy makers need accurate long-term data to control regulations for emission reductions; these include Directive (NEC) 2001/81/EC, the Kyoto developed under the UNFCCC and Montreal protocol, as well as Directive (EC) No 842/2006 specifically for fluorinated gases. For these reasons the WMO/GAW, the European Monitoring and Evaluation Programme (EMEP), research infrastructures (e.g. ACTRIS, AGAGE) and national air pollution networks included them in their long-term monitoring programmes. They define data quality objectives for the final measurement (data reported to the policy makers and quality assurance bodies). These data quality objectives (for air quality or climate trends assessment) are currently not met for all specified compounds. The high reactivity of some of them (adsorption/reaction within cylinders) and their presence at the trace level in the atmosphere complicate the dissemination to the field and the accurate calibration of monitoring instruments.

There is a further new challenge for halogenated gases: Ozone-depleting halogenated gases are already banned by the Montreal Protocol. However, with the new Kigali amendment also non-ozone-depleting long-lived HFCs are phased-out because of their greenhouse effect. This leads to emerging substitutes that require new references to ensure traceability and uncertainty. Therefore, the improvement and development of new stable references are essential, along with the correct dissemination of metrological concepts (e.g. traceability of working standards, calibration and uncertainty) to the field monitoring stations.

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The previous EMRP projects ENV56 KEY-VOCs and JRP ENV52 HIGHGAS have set a firm foundation for static and dynamic production of reference gas mixtures for a selected group of VOCs along with knowledge about surface interaction however, other species and further challenges are still present. In the framework of the ACTRIS network, an intercomparison for Non-Methane Hydrocarbons (NMHC) between 18 European laboratories (including WMO/GAW and EMEP stations) and intercomparison for VOC and oxygenated-VOCs performed showed deviations for methanol and acetaldehyde which involved: i) Stability issues at trace levels and matrix gas effect ii) Traceability to SI units and lack of references iii) Dissemination to the field, fit-for-purpose standard iv) Sampling issues and analytics.

Improvement of existing measurements carried out by the WMO/GAW VOC network, the WMO/GAW GHG network as well as other research infrastructures on assessment of long-term climate trends by providing on-site reference gas mixtures directly at ambient level and fulfilling the data quality objectives. it could also allow traceability for selected components where a traceable measurement infrastructure does not currently exist. In addition, control of anthropogenic emission, reduction policies and regulation limits for organic and halogenated compounds (e.g halogenated compounds regulated by the Kyoto and the Montreal protocols). It will provide reliable measurement to assess the temporal and spatial variability of such gas compounds to understand the impact of air quality on human health and the environment as well as the enhancement and sustainability of the collaboration between NMI/DI, measuring networks and coordination bodies.

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 VOC for the effects of climate change on Earth.

The specific objectives are

1. To develop traceable reference standards for VOCs (oxy-VOCs and terpenes) at atmospherically relevant amount fractions (1 nmol/mol – 1 µmol/mol) with relative uncertainties < 5 %.
2. To develop traceable reference standards for halogenated greenhouse gases and ozone depleting halocarbons including multi-component traceable reference materials for short-lived emerging fluorinated VOCs (e.g. HFOs) at pmol/mol atmospheric concentrations, with uncertainties < 3 %.
3. To develop working standards supporting the comparability and accuracy of field measurement to facilitate dissemination of traceability. In addition to improve sampling and analytical techniques (e.g. ground based via Fourier Transform or from satellite), and validate necessary parameters (e.g. molecular spectral parameters).
4. To facilitate the take up of the technology and measurement infrastructure developed in the project by: the measurement supply chain (accredited laboratories, instrument manufacturers), standards developing organisations (CEN, Air Quality directive NEC 2001/81/EC) and end users (e.g. WMO-GAW, EMEP, ACTRIS, AGAGE and AQUILA).

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. *(*ENV56 KEY-VOCs and JRP ENV52 HIGHGAS*)*

In particular, proposers should outline the achievements of the EMRP projects ENV56 KEY-VOCs and JRP ENV52 HIGHGAS and how their proposal will build on those.

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/514 Standardisation mandate to CEN, CENELEC and ETSI under Directive 2010/75/EU for a European standard method to determine fugitive and diffuse emissions of volatile organic compounds (VOC) from certain industrial sources to the atmosphere