EMPIR Call 2016 – Energy, Environment, Normative and Research Potential

Selected Research Topic number: **SRT-v02**
Version: 1.0

Title: Metrology for high impact greenhouse gases 2

Abstract

The accurate measurement of greenhouse gases is essential for preventing and improving knowledge of climate change. However, to enable these measurements to be made at the required level of uncertainty, new, highly accurate and traceable reference materials are required as well as reliable methodology for their analysis. In order to address this need, reference materials and methods need to be developed for the long-term accurate measurement of target analytes at relevant levels for International legislation e.g. the World Meteorological Organization (WMO) data quality objectives (DQOs). Such target analytes should include the highest impact greenhouse gases i.e. CO_2, CH_4, N_2O, and closely related tracers i.e. CO, O_2 as well as halocarbons and F-gases.

Keywords

Global climate change; global monitoring networks; greenhouse gases; F-gases and halocarbons; atmospheric composition; Global Atmospheric Watch (GAW); dynamic measurements.

Background to the Metrological Challenges

Understanding the physics and chemistry of the atmosphere and the mechanisms that control the levels of gases involved in radiative forcing are of major global concern and essential in the quest to tackle climate change. There is currently an urgent requirement for long-term accurate observations of the highest impact greenhouse gases e.g. N_2O, CO_2 and CH_4 and these measurements need to be based on accurate and stable reference standards to ensure that the data meets the requirements of the WMO DQOs, environmental policy makers as well as academic and regulatory users.

There are currently 15 primary CO_2/air standards ranging from 250 to 520 µmol/mol. Reference standards of CH_4 in air also exist and are prepared by gravimetry and cover the nominal range of 300 to 2600 nmol/mol for measurements from air extracted from glacial ice to background atmospheric conditions. However, the reference standards for both CO_2 and CH_4 are disseminated in high-pressure gas cylinders and have been the subject of intensive research to determine their accuracy and 'working' lifetime.

A European infrastructure is being delivered in EMRP JRP ENV52: HIGHGAS in order to meet the need for traceability to the SI for measurements of high impact greenhouse gases for global monitoring. However, further work needs to be done to meet emerging requirements for fluorinated gases (F-gases) and halocarbons and to drive down the uncertainties for CO_2, CH_4, and N_2O measurements in order to ensure the WMO inter-laboratory comparability targets are achieved. However, to ensure the reference standards do not negatively impact the comparability of global measurements made at different monitoring stations with different reference standards, the level of uncertainty in the reference standard must be a quarter of the WMO compatibility goals.

For the quantification of the global carbon cycle, the accurate monitoring of additional tracers (such as CO and atmospheric O_2) is equally important. Measurements of O_2 complement those of CO_2, and provided that a similar absolute accuracy can be achieved, the combination of CO_2 and O_2 monitoring makes it possible to discriminate between land and ocean uptake of anthropogenic CO_2. As the absolute uncertainty in the amount fraction of O_2 required is 400 nmol/mol (WMO recommendation), equivalent to a relative uncertainty of ≈ 1 to 2×10^{-6}, this will require a paradigm shift in preparation of reference standards and analytical capabilities.

To accompany such reference standards, new analytical methods are needed to verify the amount fraction of the analytes in the reference standards prepared. Furthermore, the reference standards must be transferred to instruments in the field, using transfer standards, which should be highly accurate and traceable to the primary reference standards and thus the SI.

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 high impact greenhouse gases.

The specific objectives are

1. To develop traceable reference standards with long-term stability for the highest impact greenhouse gases (CO_2, CH_4, N_2O) and closely related tracers (CO, O_2) with target uncertainties that support global monitoring of background levels, of 25 nmol/mol for CO_2, 500 pmol/mol for CH_4 and CO, 25 pmol/mol for N_2O and 400 nmol/mol for O_2.
2. To reduce the uncertainties of existing analytical techniques used for the validation of static reference standards, and the accuracy of the quantification of impurities in source gases (nominally pure materials e.g. cylinders of CO_2, CH_4, N_2O and air used as the matrix gases). In addition, to develop novel solutions for the stable storage of reference materials for high impact greenhouse gases.
3. To develop advanced spectroscopic transfer standards for validating field measurement techniques including in-situ calibration methodologies used by global monitoring networks.
4. To develop methods for the calibration and on-site analysis of long-lived halogenated greenhouse gases and ozone-depleting halocarbons (e.g. HCFC-22, HFC-134a, HFC-32, HFC-133a, HCFC-141b and HCFC-142b), including multi-component reference gas mixtures for F-gases and halocarbons at pmol/mol amount fractions.
5. To collaborate with the atmospheric measurement industry, standards developing organisations and end users to ensure the uptake of the reference standards and methods developed in this project. In addition, to collaborate with the ICOS (Integrated Carbon Observation System) and WMO/GAW network to ensure this work is embedded in current monitoring programmes.

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 research goes beyond this. In particular, proposers should outline the achievements of the EMRP project 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 to the project.

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 atmospheric measurement and environmental sectors.

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.