EMRP Call 2010 – Industry & Environment

Topic number: SRT-01e

Title: Traceability for global monitoring of key reactive and short lived compounds in the atmosphere

Abstract

The global trends of reactive and short-lived gases in the atmosphere and in the environment, which are central to our understanding and control of both air quality and climate and which are strongly influenced by increasing global emissions, are not well understood. An important reason for this is that many of these substances (specified in various European Directives) are difficult to measure using standard techniques since the substances are highly reactive. Research is required to develop traceable standards with long-term stability for the reactive and short-lived compounds identified by the European directives, and World Meteorological Organisation (WMO) as critical for global air quality monitoring. These include selected Volatile Organic Compounds (VOCs), nitrogen dioxide, sulphur dioxide, ammonia and certain short-lived halocarbons.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP 2008, section on "*Grand Challenges"* related to *Industry & Environment* on:

Page 4 "Activities related to the joint programme as delivered by the National Metrology Institutes, and the institutes designated by them, namely research and innovation in measurement science … Supporting quality of life and European policy"

Page 8 "A key challenge facing the EU is the need to ensure continuous and sustainable growth whilst reducing negative environmental impacts. Many of the activities required to achieve this will depend on new stable and comparable measurement standards for environmental changes and the environmental performance of new technologies. These typically involve measurements at much lower levels and over longer timescales than are required to address other themes within the EMRP."

Page 24 "Activities performed across the EU to detect changes in the environment … the EMRP will address the needs for … Novel sensors and underpinning measurements for global surface and ocean temperatures and stable long-term trends in the composition of the ocean and atmosphere".

Page 40 "metrology in chemistry: … The importance of metrological research for chemistry in Europe in particular, can be directly related to legislations in clinical chemistry, food, and environmental pollution, which require new and harmonized measurement standards for a safer and healthier environment. E.g. … 96/62/EC air quality control"

Keywords

Global monitoring networks; Global Atmospheric Watch (GAW), air quality, reactive pollutants, reactive gases, non-CO2 greenhouse gases, atmospheric composition, national emission ceilings, dynamic measurements, spectroscopic methods, transfer standard, comparison, traceability, accuracy, uncertainty, stability

Background to the Metrological Challenges

Global climate change poses one of the greatest risks to society worldwide. Consequently, there is substantial demand to improve our understanding of the global atmosphere and to control the increasing influence of human activity on it and hence to address the effects of climate change. This requires long-term observations of the chemical composition of the atmosphere.

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Several European Directives have been published that make monitoring of air pollutants mandatory these are; 2008/50/EC on ambient air quality and cleaner air for Europe, 2008/1/EC concerning integrated pollution prevention and control, 2002/3/EC relating to ozone in ambient air, 2001/81/EC on national emission ceilings for certain atmospheric pollutants, and 2000/76/EC on the incineration of waste.

There is now a capability to measure stable compounds in the atmosphere, however an issue remains in the accurate and traceable measurement of reactive and short-lived gases, which are a diverse group of compounds including Volatile Organic Compounds (VOCs) and selected halocarbons. These compounds determine the oxidizing capacity of the atmosphere and influence the formation of tropospheric ozone and aerosols, which is relevant to both air quality and climate. The compounds requiring improved measurement are typically present at parts-per-billions level in the atmosphere and therefore present substantial challenges to measurement and standards technology.

The World Meteorological Organisation's Global Atmospheric Watch (GAW) Programme plays a central role in coordinating global monitoring of atmospheric composition and addresses the main long-term objectives of the WMO Strategic Plan 2008-2011. The WMO/GAW Programme is committed to expand its current networks to form a global monitoring network for reactive gases and has approached the metrological community to help with the quality assurance, control processes and traceability. This Topic should provide this support.

High quality data on gas concentration in the atmosphere are required to establish compliance with the national emission ceilings and for regional and global climate and pollution models. However, for the important class of reactive compounds (e.g., chlorine, fluorine and sulphur compounds, ammonia and formaldehyde) current methodology often fails to provide data of sufficient quality. Established gas monitoring techniques, such as mass spectrometry or wet-chemical techniques can be slow, bulky, and expensive, making them impractical for on-site and real-time measurement. Frequent system failures often lead to gaps in the collected data. The high number of compounds that must be measured requires large investments as commonly several instruments are needed. Optical methods for reactive gas analysis offer future promise, as they allow for minimum interaction with the measurement system and can provide absolute measurements. They have enhanced versatility compared to other methods. However, essential knowledge about e.g., their sensitivity to cross-interferences or the impact of the operation conditions is still limited.

The characterisation and implementation of mobile gas standards based on permeation, diffusion and dilution does lead to better measurement comparability for reactive components, however, currently no metrological comparisons of ambient level measuring instruments have taken place because of a lack of suitable transfer standards. Mobile devices generating stable and traceable concentrations of aggressive substances would improve the situation and close an identified gap in the quality control of ambient air measurements.

Scientific and Technological 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 JRP protocol.

The overall aim of this Topic is to provide validated and reliable measurements/methods with traceability wherever it is practicable to do so.

The specific objectives are:

1. Develop traceable standards with long-term stability at nmol/mol amount of substance fractions for compounds identified by the WMO[1] and health effects research[2] as critical for global monitoring of emissions and to facilitate comparability studies and support international traceability. Generally 10% accuracy or better is required.

[1] WMO/GAW Expert Workshop on Global Long-Term Measurements of Volatile Organic Compounds (VOCs); WMO/TD - No. 1373; *GAW Report No. 171* (Geneva, Switzerland, 30 January to 1 February 2006).

[2] "Public health benefits of strategies to reduce greenhouse-gas emissions: health implications of short-lived greenhouse pollutants", Smith *et al*, *Lancet* (2009) 374 2091–103.

2. Develop primary standards with this performance through development of (i) dynamic methods for on-site generation of trace standards; (ii) sensitive optical measurement methods, particularly high-resolution spectroscopy to yield traceable spectral data; (iii) novel passivation chemistries for use in high-pressure gas cylinders with these active compounds.
3. Improve current sampling technologies for stack gas. E.g. novel portable measurement sensors.
4. Develop and validate suitable transfer standards to facilitate comparability studies and support international traceability.

Proposers shall give priority to work that meets documented stakeholder needs and may include measures to facilitate the development of European standards and Directives.

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

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the "end user" community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the "end user" community (e.g. letters of support) is encouraged.

Where a European Directive is referenced in the proposal, the relevant paragraphs of the Directive identifying the need for the project should be quoted and referenced. It is not sufficient to quote the entire Directive per se as the rationale for the metrology need. Proposals must also clearly link the identified need in the Directive with the expected outputs from the project.

In your JRP submission please detail the impact that your proposed JRP will have on the following Directives (full references at end):

[1] Directive 2008/50/EC on ambient air quality and cleaner air for Europe
[2] Directive 2008/1/EC Concerning Integrated Pollution Prevention and Control
[3] Directive 2002/3/EC relating to ozone in ambient air
[4] Directive 2001/81/EC on national emission ceilings for certain atmospheric pollutants
[5] Directive 2000/76/EC on the incineration of waste

And also the connection to the following reports
WMO/TD - No. 1373; *GAW Report No. 171*
WMO Global Atmosphere Watch (GAW) Strategic Plan: 2008 – 2015 GAW Report No. 172.

You should also detail other Impacts of your proposed JRP as detailed in the document "Guidance for writing a JRP"

You should detail how your JRP results are going to:

- feed into the development of urgent standards through appropriate standards bodies
- transfer knowledge to the air quality, pollution, and waste sectors
- feed into complementary existing projects of GAW, WMO, etc

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology. 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 Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of 3 years duration.

Additional Information

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

Directives:

[6] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF

[7] Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 Concerning Integrated Pollution Prevention and Control http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:024:0008:0029:en:PDF

[8] Directive 2002/3/EC of the European Parliament and of the Council of 12 February 2002 relating to ozone in ambient air http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:067:0014:0030:EN:PDF

[9] Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001on national emission ceilings for certain atmospheric pollutants http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:309:0022:0030:EN:PDF [Ozone Directive see Annex VI , "Measurements of Ozone Precursor Substances".

[10] Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:332:0091:0111:en:PDF

Other References:

[11] WMO/GAW Expert Workshop on Global Long-Term Measurements of Volatile Organic Compounds (VOCs)" WMO/TD - No. 1373; GAW Report No. 171 (Geneva, Switzerland, 30 January to 1 February 2006)

[12] WMO Global Atmosphere Watch (GAW) Strategic Plan: 2008 – 2015 GAW Report No. 172.

[13] Public health benefits of strategies to reduce greenhouse-gas emissions: health implications of short-lived greenhouse pollutants", Smith et al, Lancet (2009) 374 2091–103.

[14] Extensive halogen-mediated ozone destruction over the tropical Atlantic Ocean", Read et al, Nature 453 (2008) 07035.

[15] Climate Change 2007 - The Physical Science Basis", Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007).

[16] Copenhagen Accord" UNFCC Fifteenth session Copenhagen, December 2009.

[17] World Industrial Gas Sensors Detectors and Analyzers Markets. Frost and Sullivan, August 2006

[18] Consultative Committee for Amount of Substance: metrology in chemistry (CCQM). Report of the 15th meeting (22–24 April 2009)

[19] EUROMET Workshop on "Comparability of measurements of NO, CO, and SO2 at low ambient level"*14-15 March 2007* http://ies.jrc.ec.europa.eu/the-institute/units/transport-and-air-quality-unit/action-13203/workshop-conferences/euromet-workshop.html

[20] International Key Comparison CCQM-K26b and Pilot Study CCQM P50b (So2) "Comparison of primary standards of Sulphur Dioxide in Synthetic Air" http://www.bipm.org/utils/common/pdf/final_reports/QM/K26/CCQM-K26.b.pdf