EMRP Call 2013 – Energy and Environment

Selected Research Topic number: **SRT-v09**
Version: 1.0

Title: Traceability for atmospheric total column ozone

Abstract

Currently, surface atmospheric total column ozone measurements originate from two global networks; the Brewer and Dobson spectrophotometers. To obtain consistent measurements in each network, the retrieval of total column ozone is based on measurement procedures at nominal wavelengths, partly identical instrumental characteristics, a recommended dataset of ozone absorption cross-sections and calibration coefficients retrieved by comparison to a reference instrument. However, measurements between the two networks show seasonal and absolute deviations of up to 3 %. Therefore, the goal is to produce traceable measurements of total column ozone with a target uncertainty of 0.5 %, that are independent of instrument type, by a systematic investigation of radiometric, spectroscopic and methodological characteristics.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Energy and Environment on pages 8, 9, 24, 25 and 34.

Keywords

Total column ozone, climate change, atmospheric total ozone, solar UV radiation, reference spectroradiometers, calibration, cross-sections, spectroscopy

Background to the Metrological Challenges

The stratospheric ozone layer screens harmful ultraviolet radiation from reaching the Earth’s surface. Since the 1970’s, human-produced chlorofluorocarbons have led to losses of total ozone in the Antarctic and more recently the Arctic, while in middle-latitudes, moderate ozone depletion has been observed. Therefore, careful monitoring of the global ozone layer and any recovery in it is crucial. The most reliable total column ozone measurements are currently obtained from UV spectroradiometers, measuring the differential absorption of ozone in direct solar irradiance measurements. Two instruments, the Dobson and Brewer spectrophotometers, are responsible for the most extensive ground-based measurements. The Dobson spectrophotometer network has the most extensive dataset, starting in 1926, while the Brewer spectrophotometer started measurements in the early 1980’s. Although each instrument is, in itself, consistent, total column ozone measurements between from the two instruments can differ by up to 3 %.

These discrepancies have been traced to three main reasons: firstly, uncharacterised instrumental features; secondly, inconsistent ozone absorption cross-sections and thirdly differing assumptions on atmospheric composition (vertical profiles of ozone and temperature), resulting in seasonal variability of retrieved ozone values. The current work-around to these discrepancies is to define the common parameters to be used so that total ozone retrievals remain consistent among each instrument group. However, problems have occurred when new ozone absorption cross-sections were introduced or when different wavelength regions were used for the ozone retrieval from solar radiation measurements. Furthermore, the discrepancies between different instrument types prevent the phase-out or replacement of the ageing Dobson spectrophotometer with newer instruments as this would result in a gap in the series of ozone 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 JRP shall focus on the traceable measurement and characterisation of atmospheric total column ozone.

The specific objectives are

1. Optical characterisation of spectroradiometers used for total column ozone measurements (e.g. bandpass, in-range and out-range stray light, wavelength alignment, temperature coefficients, linearity).
2. Development of next generation spectroradiometers based on array detectors. This should include investigating the total ozone retrieval procedures applied to different spectral ranges using traditional double-ratio, spectral, and DOAS methodologies.
3. Determination and validation of high resolution solar reference spectrum in the range 305 nm to 800 nm with a resolution of 0.05 nm or less and an expanded uncertainty of 1 %.
4. Determination and validation of ozone cross-sections in the UV, visible and infrared spectral regions, in the stratospheric temperature range 193 K to 293 K, with the aim of obtaining consistent ozone concentrations with a target uncertainty of 0.5 % or less.

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 R&D work, the involvement of the user community such as industry, and standardisation and regulatory bodies, as appropriate, is strongly recommended.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this and EMRP JRP ENV03 (SolarUV) 'Traceability for surface spectral solar ultraviolet radiation'.

EURAMET expects the average size of JRPs in this call to be between 3.0 to 3.5 M€, and has defined an upper limit of 5 M€ for any project. Any proposal received for this SRT is expected to be significantly below 3.0 M€. The available budget for integral Research Excellence Grants is 30 months of effort.

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 (eg letters of support) is encouraged.

You should detail how your JRP results are going to:

- 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 detailed 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 the EMRP to develop a coherent approach at the European level in the field of metrology and includes 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 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 up to 3 years duration.