EMRP Call 2013 – Energy and Environment

Selected Research Topic number: **SRT-v17**
Version: 1.0

Title: Optical metrology for Earth observation

Abstract

Quantitative and reliable observations of Earth climate dynamics and changes from space represent a unique tool to monitor the health status of our planet. Optical instruments employed for this need to be characterised and calibrated against standards in order to transfer and maintain the level and accuracy of ground-based calibrations to orbit. The current accuracies require focused and dedicated metrological solutions, in order to improve the state of the art and to monitor climate changes, on short and long-term time scale, “beyond any doubt”. Improvement in the characterisation of space optical instrumentations for wavelength, polarisation, non linearity and spectral slit width is needed.

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 and 23/24/25.

Keywords

Climate changes, Earth monitoring and observation, remote sensing, pre-launch calibration of optical instruments

Background to the Metrological Challenges

The ability to perform quantitative and reliable observations of Earth climate dynamics and changes from space represents a unique tool to monitor the health of our planet. Climate change and global warming have been identified as the major challenges to be faced worldwide. This has been highlighted in the FP7 Space advisory Group (SAG) final report (commissioned by the EU), the Foresight: International Dimensions of Climate Change Final Project Report and the Lund Declaration. [1, 2, 3] The European metrology community is expected to contribute to tackling this challenge by providing accurate, reliable, and traceable measurements of Essential Climate Variables (ECV). The SAG’s report has also clearly and explicitly pointed out the importance of being able to relate such measurements to ground truth in a systematic and traceable manner and to assign levels of confidence (i.e. measurement uncertainties) to such data. The need for traceable measurements for optical instrumentation (UV-VIS-NIR) used for Earth observation, is also the key message of the ASIC3 report [4].

The need is to increase the accuracy of satellite based instruments for Earth Observation, with the goal of providing a sound basis for reliable measurements of specific ECVs, traceable to the absolute standards kept and maintained at NMIs. Traceability to absolute standards with well-underpinned uncertainty budgets at each step in the traceability chain is required. These metrology needs are also fully in line with the technical requirements of future ESA space missions dedicated to monitoring the composition of the atmosphere [5, 6].

Current pre-launch wavelength scale calibration of optical instruments and sensors, from UV to NIR, barely reach 50 pm accuracy. Methods to improve the accuracy by a factor of two up to ten and, at the same time, to extend it to a virtual continuous range of wavelengths, are needed. The characterisation of the polarisation response of instruments can currently be obtained at 1 % level in the UV/VIS and a few % levels in NIR. The reduction of these values over a complete set of operating wavelengths, is required. In most cases instruments are required to be polarisation insensitive up to 0.5 % level. A characterisation of the instrument spectral response function is a prerequisite for any quantitative observation. This can be obtained, with the necessary accuracy, only in regions of the electromagnetic spectrum where known and narrow reference lines are available. Current accuracies are a few % of line peak but this does not meet the need for Earth

EURAMET, EMRP-MSU
National Physical Laboratory
Hampton Road, Teddington,
Middlesex, TW11 0LW, UK

Phone: +44 20 8943 6666
emrpA169@npl.co.uk
www.euramet.org

EMRP
European Metrology Research Programme
Programme of EURAMET

The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

Observation applications, where usually a characterisation of slit width function within 1 % line-peak is required.

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 optical instruments aboard Earth observations satellites with a focus on spectral and polarisation metrology.

The specific objectives are

1. To develop devices, models and methods for a full pre-launch wavelength scale calibration with accuracy below 20 pm level in the whole UV/NIR/VIS-range. Methods, such a broad-band filtering, cavity multimodes excitation etc, can be considered as possible tools to achieve this.
2. To develop a method for complete characterisation of the polarisation response of instrumentation, with accuracy below 1 % in UV/VIS and below 4 % in NIR, and to characterise its wavelength dependence.
3. To develop devices, models and methods for the characterisation of non-linearity response of instrumentation working in large dynamic ranges.
4. To design and realise methods for accurate characterisation of the instruments spectral response function (in terms of form, dispersion, asymmetry, or under non-uniform illumination) within 1 % line-peak accuracy.

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. In particular, proposers should outline the achievements of the EMRP project ENV04 and how their proposal will build on those.

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. 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.
- Provide a traceability chain for the ECVs

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.

Additional information

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

[1] Space research in Horizon 2020, Recommendations of Fp7 Space Advisory Group (SAG), December 2012, http://ec.europa.eu/research/fp7/pdf/advisory-groups/sag_paper_on_space_research_in_h2020_december_2012.pdf#view=fit&pagemode=none.

[2] *Foresight,* International Dimensions of Climate Change*, Final Project Report, The [UK] Government Office for Science. London, July 2011.*

[3] Lund Declaration 2009, http://www.se2009.eu/polopoly_fs/1.8460!menu/standard/file/lund_declaration_final_version_9_july.pdf.

[4] Achieving Satellite Instrument Calibration for Climate Change (ASIC3), http://www.star.nesdis.noaa.gov/star/documents/ASIC3-071218-webversfinal.pdf.

[5] ESA, GMES Sentinels-4/-5 Mission Requirements Traceability Document.http://esamultimedia.esa.int/docs/EarthObservation/S4_5_5p_MRTD_issue_1.0_authorised.pdf

[6] ESA, GMES Sentinels-4/-5 Mission Requirements Document, http://esamultimedia.esa.int/docs/GMES/Sentinel4and5MRDissue1rev0signed.pdf