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

Selected Research Topic number: **SRT-v12**
Version: 1.0

Title: Metrology for earth observation and climate 3

Abstract

Due to the arguments of climate change sceptics and the large uncertainty in climate modelling/forecasts, accurate and validated long term base measurements of Essential Climate Variables (ECVs) are needed to improve our knowledge of the Earth. Currently, of the 50 ECVs, 50 % require remote observation from satellites and a further 25 % need some satellite measurements. Therefore, improving the traceability and accuracy of ECV data, in particular from satellites, would result in more reliable climate forecasts and increased confidence for climate adaptation & mitigation policies.

Keywords

Remote sensing, Climate, Essential Climate Variables, Radiometry, Satellites, Earth Observation, Global Climate Observing System

Background to the Metrological Challenges

The harshness of the operational environment in space, as well as the launch and environmental conditions on aircraft and at extreme remote sites of earthbound observation all cause significant and unpredictable changes in the performance of remote-sensing instrumentation. Therefore, re-assessment of the accuracy of satellite instrumentation post-launch as well as the recalibration of airborne and ground based instrumentation at regular intervals is essential. In some cases, re-assessment and recalibration can be achieved on-board the satellite/aircraft but predominantly well-calibrated large area natural targets are needed, or as a minimum an independent (in-situ) measure of the same variable/parameter to calibrate against. The World Meteorological Organisation (WMO) and Group of Earth Observations (GEO) are currently trying to establish validation sites and networks of test-sites and/or other methods for the post-launch calibration and validation of sensors. However, in order to establish fully traceable pre-flight and post-launch calibration and validation, traceability to SI needs to be established, including the development of new SI standards and transfer standards and the incorporation of metrological best practise into sensor design.

Transition of the World Radiometric Reference (WRR) to the SI was one of the key outputs from the previous EMRP projects ENV04 MetEOC and ENV53 MetEOC2. However, with the integration of the WRR into other scales, there is now an urgent need to extend SI traceability to other similar radiation scales such as the Baseline Surface Radiation Network (BSRN).

Validation sites for vegetated products and associated bio-geophysical ECVs are of increasing importance, not only for the Copernicus Sentinel S2 and S3 missions of ESA and the EC, but also for the Meteosat Third Generation (MTG) and EUMETSAT Polar System Second Generation (EPS-SG) satellite missions.

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 ECVs used for global earth observation systems.

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The specific objectives are

1. Enable harmonisation of remote sensed 'level 1' (e.g. radiance, reflectance, Irradiance) measurements of the Earth through improving the accessibility and usability of SI traceable standards in pre- and post-launch calibration and validation together with mathematical techniques to remove the effect of residual biases. This should include further prototyping to increase the readiness and prospect of the flight of an SI traceable reference satellite such as TRUTHS/CLARREO and should build on transportability and the increasing demand for reduced mass/size to address the needs of small satellites as they start to seek to make climate quality measurements.
2. To further enhance the capabilities of autonomous 'SI traceable' networks of test-sites and/or other methods for the post-launch calibration and validation of sensors and derived bio-geo physical products. This should include uncertainty analysis, taking into account the "non-representativeness" of sampling and focus should be placed on the needs of Copernicus Sentinels (including S2 and S3), Meteosat Third Generation (MTG) and EUMETSAT Polar System Second Generation (EPS-SG) satellite missions. One priority example would be the measurement of biomass where a target improvement of >30% is needed for sentinel 2 and in readiness for the ESA BIOMASS mission.
3. To establish a method for assigning aggregated quality metrics to a broad range of bio-geophysical ECVs, long term climate data records and the monitoring of mitigation strategies, through 'end to end' analysis. Building from previous 'top level' analysis this should address identified gaps and weaknesses such as retrieval algorithms, validation processes and in particular the use of historic data from extinct and/or not fully characterised sensors such as the ATSR series, with the ultimate goal of facilitating the provision of metrologically 'trustable' long time base climate information to policy makers and commercial users.
4. To develop methods for enhancing the SI traceability of ground based networks used for climate monitoring such as BSRN of WMO and Network for Detection of Mesopause Change (NDMC) particularly where they are based on community based scales (e.g. World Infrared Standard Group (WISG) and World Radiometric Reference (WRR)). Where necessary to develop new SI standards/instruments to facilitate dissemination of improvements made in earlier primary realisations.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by the standards developing organisations, measurement supply chain (accredited laboratories, instrument manufacturers) and end users (environmental monitoring and regulation bodies such as the World Meteorological Organisation (WMO) and Group of Earth Observations (GEO)).

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 projects ENV04 MetEOC and ENV53 MetEOC2 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 environmental, climate change and space agency 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.