EMPIR Call 2018 – Networks

Selected Network Topic number: **SNT-w02**
Version: 1.0

Title: Support for a European Metrology Network on climate and ocean observation

Abstract

Earth's climate is changing. The potential for societal catastrophe is second to none. Trustable global data providing evidence for policy makers to make timely decisions on mitigation and investments for adaptation is needed. This requires decadal observations of the Earth system to extract the small signals from noisy backgrounds - a metrology grand challenge. The observables are complex and require multi-disciplinary metrology from the coordinated efforts of the worlds NMIs, to achieve laboratory quality uncertainties from space, deserts & oceans.

The European Union's current Integrated Maritime Policy (IMP) focusses on "Blue Growth" - harnessing the untapped potential of Europe's oceans, seas and coasts to stimulate long-term economic development and job creation. Observing the Oceans is not only necessary for climate purposes but also to provide knowledge that can promote European Growth.

EURAMET intends to establish a collaborative network of climate and ocean observing tailored metrology expertise encompassing all technical domains as a single focal point for stakeholders to prioritise research and access services.

This SNT is intended to support that network in their initial tasks.

Keywords

Climate-change, Environment, Earth Observation, Satellites, Ocean, Land, Atmosphere, Essential-Climate-Variables (ECVs), Essential Ocean Variables (EOVs), SI traceability and measurement uncertainty, Marine measurement standards, Ocean observation systems, Quality Assurance/Quality control (QA/QC) schemes, Calibration infrastructure, Marine sensors, On-site measurements, air monitoring networks, Data Quality Objectives (DQO), greenhouse gases, aerosols, reactive gases.

Background

> "warming of the climate system is unequivocal. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased. It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century" [2].

This conclusion has finally led to the now widely ratified Paris accord of 2015 which seeks to contain the rise in temperature of the Earth to <2 °C above pre-industrial levels with a highly ambitious, but arguably necessary, target of <1.5 °C [3]. Even if this higher-level goal is achieved, the world still faces significant consequences from embedded climate change and there remains an urgency to establish a robust integrated global climate observing system to monitor all the ECVs [1], as well as the specific anthropogenic forcing agents and their mitigation e.g. Green House Gases. Monitoring of these now 50+ ECV's with sufficient accuracy to detect change beyond that of natural variation in the shortest possible time is the primary focus of the World's climate observing community and is driven by the political agenda at the highest levels as the societal impact of failure is unimaginable. The signals are so small they require decades to reach a magnitude where they can be reliably detected by current instrumentation. The metrology challenge is to ensure that these long-duration measurements can be trusted whilst in parallel seek to improve measurement capabilities. The former, together with international harmonisation (also essential for global measurements), are amongst the foundational pillars for the SI.

Although ECVs involve measurands that can ultimately be related to SI units, in many cases they are biophysical in nature and require observations to be made in challenging environments. Thus, they each

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typically involve metrology expertise from a range of disciplines. For example, a 'simple' ECV such as Sea Surface Temperature (SST), requires expertise in: optical & microwave radiometry, temperature and mathematics. Similarly, SST requires observations, from a range of platforms: satellites, aircraft, ships, non-returnable buoys as well as robotic underwater drones, and is anticipated to change (climate forcing) by only a few tenths of a °C per decade, placing severe challenge on metrology. Half of ECVs only require satellite observations, however, even these still require high accuracy SI traceable *in-situ* measurements for validation. This has led space agencies to invest in some existing '*in-situ* networks' which were not previously designed for climate, but in doing so have emphasised the need for metrological best practise. Although willing to upgrade, some, in the *in-situ* community are not always clear as to what is needed and how to optimally achieve it. A particular challenge is the identification of sources of error and the creation of a full uncertainty budget in a consistent and metrologically robust manner [4-8].

The European Union's current Integrated Maritime Policy (IMP) focusses on "Blue Growth" - harnessing the untapped potential of Europe's oceans, seas and coasts to stimulate long-term economic development and job creation. Observing the Oceans is not only necessary for climate purposes but also to provide knowledge that can promote European Growth. "Marine Knowledge 2020" clearly states that "at present the majority of marine data collected by public institutions in EU Member States, individually or collectively, [costs] more than €1 billion annually…" and acknowledges that "Fragmented standards, formats and nomenclature, lack of information on precision and accuracy…are…barriers [to the proper management and use of data]". The Marine Strategy Framework Directive 2008/56/EC (MSFD, 2008) states that "provision should be made for the adoption of methodological standards for the assessment of the status of the marine environment, monitoring, environmental targets and the adoption of technical formats for the purposes of transmission and processing of data…". The report on the European Marine Observation and Data Network (EMODnet) Impact Assessment (Commission Staff Working Document, 2010) observed: "A better measurement infrastructure will reduce uncertainty in the future behaviour of the oceans. This will allow more certainty by business and public authorities in planning for the future". The same report also identifies "difficulty combining data from different sources" and "quality, precision and accuracy unknown" as handicaps to potential users of gathered data [9].

With >50 ECVs, many of which can be, and are, addressed by a multitude of complimentary observing techniques, how and where NMIs should focus limited resources to obtain maximum impact for society urgently requires a strategic plan and significant coordination both at European and global levels. No single NMI has the expertise or resource to tackle all or even a significant fraction of the most critical priorities without collaboration. Without coordination, there is a strong likelihood of unnecessary duplication, with NMIs (nationally and/or regionally) potentially independently choosing to focus efforts on the same challenge with consequential neglect of others. EURAMET intends to establish a European Metrology Network to coordinate the European NMI response, to establish close links to the stakeholder community, to develop and implement a strategic agenda and establish a knowledge, technology transfer and promotion plan, to ensure an effective response is put in place. This SNT is intended to support that network in their initial tasks.

Objectives

Proposers should address the objectives stated below, which are based on the PNT 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 / legal / regulatory / market constraints, but the reasons for this should be clearly stated in the protocol.

The JNP shall focus on developing a long term ongoing dialogue between the metrology community and relevant stakeholders. This dialogue should support the take-up of research outputs from the metrology community and the collection of needs from industry to inform future research.

The specific objectives are

1. To establish an actively moderated forum for an ongoing dialogue to collect requirements on the metrological needs related to climate monitoring and mitigation and ocean observation. Allowing engagement with stakeholders to define research priorities, strategies and roadmaps for metrology. Stakeholders include: policy makers, scientists (data collectors, modellers, information service developers), research organisations, space agencies, EU bodies such as EOOS, JPI Oceans and Copernicus and international coordinating bodies such as WMO, GEO, GCOS, CEOS, etc. Where appropriate this should utilise and interface with existing stakeholder structures.
2. To create a European focal point ('one stop shop') for the provision of metrological guidance and associated services available for the climate and ocean observation and the associated measurement and information user community. To provide links and summaries of on-going

and concluded national and coordinated research (e.g. EMPIR and other H2020 relevant research) and a directory of available services and expertise.

3. To establish a strategic agenda for European Metrology in the Atmospheric Observation, Earth Observation and Ocean Observation areas seeking to ensure that, for any specified ECV, the necessary traceability to the SI can be supplied by at least one of the European NMIs or DIs into the relevant traceability chains. This should include a strategy for interaction with the Central Facilities offered by the WMO. The agenda should also include roadmaps to support future research on new standards and new calibration concepts and to create the conditions for the sustainability of the network.

4. To up-skill the European workforce by developing and disseminating training material on uncertainty estimation and analysis tailored to climate sciences, build upon existing material, targeting a variety of expertise levels through: e-learning, webinars, video, face to face courses etc including 'thesaurus like' content to clarify and standardise key terminology, particularly when translated between languages.

The proposed activities shall be justified by clear reference to the measurement needs within strategic documents published by the relevant stakeholders. Proposers should establish the current state of the coordination in this area, and explain how their proposed project goes beyond this.

The proposed activities should not include those essential for the establishment and operation of the EMN. EMNs will be established and operated by the EURAMET members using their own national resources regardless of whether specific EMPIR proposals are funded. EMPIR funding is for specific tasks aimed at ensuring a planned EMN will progress quickly towards contributing to the objectives of the programme.

EURAMET expects the average EU Contribution for the selected JNPs in this TP to be 0.4 M€, and has defined an upper limit of 0.5 M€ for this project.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the "end user" community, describing how the project partners and collaborators will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the sustainability of the organisation. Evidence of support from the "end user" community (e.g. letters of support) is also encouraged.

You should detail how your JNP results are going to:

- Address the SNT objectives and deliver solutions to the documented needs,
- Provide a lasting improvement to coordination in the European metrological community and communication with their stakeholders beyond the lifetime of the project,

You should detail other impacts of your proposed JNP.

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

Time-scale

The project should be of up to 5 years duration.

Additional information

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

[1] https://public.wmo.int/en/programmes/global-climate-observing-system/essential-climate-variables
[2] https://ipcc.ch/report/ar5/
[3] http://unfccc.int/paris_agreement/items/9485.php
[4] https://www.bipm.org/utils/common/pdf/rapportBIPM/RapportBIPM-2010-08.pdf
[5] http://www.npl.co.uk/content/ConPublication/6728
[6] http://www.frm4sts.org/activities/event-5-international-workshop-npl/

[7] https://earth.esa.int/documents/700255/3194632/RadWS_MoM_Final.pdf/5fd20f68-60b3-488a-a2bd-32a3043a21
[8] https://earth.esa.int/web/sppa/meetings-workshops/expert-meetings/workshop-on-uncertainties-inremote-sensing/programme
[9] R. Feistel *et al*., "Metrological challenges for measurements of key climatological observables: oceanic salinity and pH, and atmospheric humidity. Part 1: overview," Metrologia, vol. 53, pp. R1-R11, 2016