Publishable Summary for 18NET04 ForClimateOcean
Support for a European Metrology Network for Climate and Ocean Observation

Overview

Understanding climate change and enabling economic growth through the European Union's 'Integrated Maritime Policy' (IMP) and innovative climate services require reliable observations of climate and ocean parameters. This 5-year project is carrying out a review of metrological requirements for the climate and ocean communities and establishing the European Metrology Network (EMN) for Climate and Ocean Observation as a recognised single focal point for stakeholders. It is also defining a strategic research agenda (SRA) for the EMN to facilitate more aligned and coordinated research by the metrology community to meet stakeholder needs and sharing training materials, to deliver opportunities for improved understanding between metrologists and stakeholders.

Need

The 2015 Paris Agreement seeks to limit the rise in the Earth's average temperature to reduce the risks and impacts of climate change. Governments and other policy makers need to make complex, inter-related decisions to meet ambitious targets, require reliable climate models, and a robust, integrated, observing system. The Global Climate Observing System (GCOS) defined 55 Essential Climate Variables (ECVs) to enable the global, multi-decadal observation of small climate trends on data that is noisy due to natural variability.

Ocean and marine resources contribute to human well-being and ecosystem integrity. Over three billion people depend on marine and coastal resources for their livelihoods. In addition, oceans are crucial for global food security and human health. In this respect, the Global Ocean Observation System (GOOS) has defined a set of Essential Ocean Variables (EOVs) which include both the ocean ECVs and additional parameters that are important for other ocean activities.

To provide robust, interoperable and long-term data records, GCOS and GOOS will need to be underpinned by metrological principles. Significantly, the Quality Assurance Framework for Earth Observation (QA4EO), the World Meteorological Organization's Global Atmosphere Watch (WMO-GAW) and the EOOS Steering Committee all encourage the application of metrological techniques.

To achieve interoperable observations, the metrological community collaborates with ECV and EOV experts, to perform research and to design metrological services enabling 'in the field' (or in space) measurements made 'fit-for-purpose' with uncertainties tailored for the most demanding observational environments. Metrological principles also support the analysis of large-scale environmental data records. Previous EMRP/EMPIR projects ENV04, ENV53, 14SIP04 and 16ENV03 delivered impact, but the scale of the challenge (responding to all ECVs) demands further European coordination of metrological capabilities so priority requirements can be addressed.

The EMN for Climate and Ocean Observation was established with three sections, based on the GCOS classification of ECVs: Atmosphere, Ocean and Land. All sections support the climate needs and, to reflect the broader economic needs related to the oceans, the Ocean theme additionally has an emphasis on the full range of EOVs. The Land theme is combined with the broader Earth Observation theme which incorporates 'remote sensing' methods in general (satellites, aircraft, etc.) and their validation for all thematic domains: Land, Ocean and Atmosphere. The EMN supports these three sections and is a platform to support harmonisation within and between the three sections. This project is needed because the EMN covers an

extremely broad scientific area and many stakeholders, while also being of high societal importance. The project supports the EMN in providing impact to the communities as quickly as possible.

Objectives

The aim of the project is to accelerate establishing a strong, collaborative and long-term self-sustaining EMN, capable of understanding and responding to important stakeholder requirements. The project addresses the following objectives:

1. To establish a forum for an ongoing dialogue to understand metrological needs related to the three themes of the EMN (Land, Ocean and Atmosphere) and those of overseeing organisations operating in all three themes. Facilitating engagement with stakeholders, including policy makers; scientists and engineers; research organisations; space agencies; EU bodies such as EOOS, JPI Oceans and Copernicus; and international coordinating bodies such as WMO, GEO, GCOS, CEOS, etc.
2. To create a European focal point (one-stop-shop) for metrological guidance and associated services to climate and ocean observation user communities. To provide links and summaries of on-going and concluded national and coordinated research and a directory of available services and expertise tailored to stakeholder needs.
3. To establish a strategic research agenda (SRA) for European Metrology in the Atmospheric, Terrestrial and Oceanic Observation areas to ensure that, for all appropriate ECVs and EOVs traceability to the SI or to a community reference can be supplied by at least one of the European NMIs or DIs. The SRA will define research priorities, strategies and roadmaps for metrology to develop the necessary knowledge and infrastructure and to interact with all the relevant international networks and coordination bodies. The SRA will cover the three ECV areas, include a section on cross-cutting techniques such as Earth Observation and will explicitly consider synergies between the different themes. The SRA will also create the conditions for the long-term operation of the EMN including interaction with the Central Facilities offered by the WMO, and other relevant metrology expertise beyond the NMIs and DIs.
4. To disseminate training material on uncertainty estimation and analysis tailored to climate and oceanographic sciences, through e-learning, webinars, video, face-to-face courses and providing ‘thesaurus like’ content to clarify and standardise key terminology.

Results

Objective 1: Engagement with stakeholders and stakeholder needs review

This objective is for the project to perform two thorough reviews (2019 and 2023) of climate and ocean community stakeholder requirements so that these can inform the SRA. Both reviews determine community needs and establish the infrastructure for a long-term dialogue between metrology and direct and broader stakeholder communities. The direct stakeholders for the EMN are the operators of observing networks and observing satellite sensors and the manufacturers of observation instrumentation, as well as those research and commercial organisations that specify the requirements and/or use the data and information derived from observations. These communities are often organised through international bodies. Broader stakeholders include the users of the observation data, from climate modellers to public and commercial service providers creating software applications for environmental information and their end-user customers: the governments, agriculture, fisheries and industry.

The first review of stakeholder needs was carried out during 2019 and 2020. The review involved stakeholder workshops, online surveys with 55 responses, and the review of 100 strategies, position papers and scientific publications. We attended stakeholder meetings and discussed our survey with stakeholders at those meetings and wrote a report that was first reviewed by 8 of our key stakeholders, our members and EURAMET officials, and, after edits, was then published on our website in January 2021.

In preparation for a second review, in 2022 we supported and significantly contributed to the organisation of the September 2022 BIPM-WMO Metrology for Climate Action workshop, with project’s partners active on the meeting’s steering committee and the first stakeholder needs review informing the discussions at the workshop and being used in the development of workshop recommendations. EURAMET provided additional weight to the event as a formal workshop sponsor. The outcomes of that workshop, which benefitted from the input of

over 1000 relevant stakeholders, are anticipated to be published in June 2023. These recommendations will be used at the EMN annual meeting to inform discussions about collaborative research efforts.

Objective 2: Creating a European Focal Point

This objective is for the project to develop the EMN into a single point of focus for metrology for climate and ocean observation in Europe. There are two parts to that – first, it is to provide easy-to-access information about NMI and DI capability through a webpage, and second, to develop a concept for a long-term operational framework and infrastructure for how the European NMIs and DIs will work together to offer a coordinated service provision to Europe's climate and ocean observation communities.

During the first year of the project, we surveyed all member institutes of the EMN to identify their activities in support of the ECVs and EOVs. The results were discussed during a members' workshop in June 2019. In 2021, we refined this analysis by collating information from EMN members according to the metrology challenges identified in the stakeholder needs review report. In 2022, we set up an EMN strategy working group to consider options for the long-term operation of the EMN. This working group surveyed the EMN members and the directors of NMIs and DIs in Europe and refined options about the ongoing operation of the EMN for discussion at the EMN's Annual General Meetings in June 2022 and 2023.

Objective 3: Establishing a strategic research agenda for the EMN

This objective is to establish a strategic research agenda (SRA) for the EMN and to create the framework/infrastructure for this SRA to be reviewed and updated by the EMN thereafter. A first SRA was completed during 2021/22 in the form of a technical roadmap in response to each need identified in the stakeholder needs report. The SRA was reviewed by some key stakeholders, EMN members and EURAMET officials, and published on the EMN website in September 2022.

Objective 4: Developing and disseminating training material

This objective is about developing and disseminating material that will support stakeholder communities to understand principles and benefits of metrology, primarily by new capability to apply core concepts of uncertainty analysis, traceability and comparison. For this, the project ensures the EMN is well known among targeted communities, and that training material, such as e-learning, webinars etc, are available. The project will provide a dissemination platform and promotion vehicle for training material, tailored to different target groups developed in previous collaborative projects, as well as suitable more recent material produced by EMN partners.

The project has facilitated metrological training to be given in person to scientists working at the European Space Agency (at the ESTEC and ECSAT sites), and to EUMETSAT. Presentations have also been given at several conferences, to the European Parliament and Commission, at COP26, and directly to stakeholder communities through project's partners participating in their committees. During the final year of the project the website will be updated to include training material developed in other projects and by EMN members.

Impact

Europe is the world-leader in evidence-based decision making on climate change mitigation and adaptation. This project is supporting the EMN to provide a strong metrological foundation to European climate data records. Such a foundation could significantly improve climate models in as short a time as possible and facilitate rigorous testing of such models to reduce variance in forecasts. Similarly, a secure metrological foundation for the oceanographic networks, and the integration of new ocean monitoring technologies into the existing infrastructure, will provide more robust oceanographic models and thus more reliable decision making in the commercial exploitation of its resources in a sustainable manner. In both climate and ocean themes, more reliable measurements support international agreements such as the UN SDGs, the 2015 Paris Agreement, European directives and policies such as the Integrated Maritime Policy and UNFCC rules.

The direct impact of this project is to accelerate the creation of the EMN and its sustainable integration into the climate and ocean observation community in Europe. In this context the impact of this project arises from increased recognition and support of the EMN by its stakeholders, an acceleration of the formation of the network and a reduction in time for the EMN to reach its full maturity. It also includes ensuring a strong participation of Europe's NMIs and DIs in the EMN to support the coordination activities of the EMN and to support the network to be 'more than the sum of its parts'.

To date, the project partners presented to or engaged with relevant communities at 17 standardisation meetings; published a paper in a peer reviewed publication; presented orally or by poster at 20 conferences (mostly international); contributed to five training events; and distributed content via twenty-nine website articles, at workshops and various other events.

Early evidence of the benefits of such recognition includes the International Oceanographic Commission contacting the EMN to partner with its 'best practices working group' and communities approaching the EMN directly to ask for metrological participation in projects. The Horizon Europe project Minke, a consortium of the oceanographic community, has specific deliverables in its own programme to connect with the EMN. In the atmospheric area, both ACTRIS and ICCOS formally requested to become EMN partners. The EMN, supported by the project has influenced different communities, with one EMN member becoming a WMO-GAW central calibration laboratory, and another EMN member influencing the development of guidelines for satellite fiducial reference measurements.

Informed by its strategic research efforts, the EMN (and JNP) strongly influenced discussions of the BIPM WMO Metrology for Climate Action Workshop in September 2022 and helped realise formal recommendations, due to be published in June 2023. Recognition of the value of JNP member contributions was reflected in the extensive involvement in the workshop, including chairing theme 1, acting as chair or rapporteur of three of the nine topic areas across themes 1 and 2, and that JNP and EMN members gave around 20 presentations and participated in technical discussions in all nine themes. Considering the breadth and global nature of this event, these recommendations may, in due course, produce a considerable amplification effect.

The EMN was approached by the EUMETSAT-led, Copernicus-funded project TRUSTED, which aims to establish Fiducial Reference Measurement (FRM) network for ocean temperatures. Three EMN members provided ongoing consultancy for that project. This connection came out of a visit to EUMETSAT, and long-term conversations with both EUMETSAT and ESA about the importance of metrological approaches to FRMs. This recognition was also explicitly documented in the GCOS 2022 Implementation plan

Many EMN members have strong existing collaborative links with the many various communities engaged in climate and ocean observation. The main role of the EMN is therefore to connect these efforts together through a common metrological approach. The project also supported the EMN to connect different activities together, with the 2023 annual general meeting proving particularly successfully at connecting Europe's metrologists to share approaches and to look at cross-disciplinary collaboration opportunities. Approximately 10 organisations that are not formal members of the EMN also participated in that meeting.

By developing a clear understanding of user needs and establishing a clear strategic direction for the EMN, the project is enabling the European metrology community to take a new approach to meeting our stakeholders' requirements. The completed stakeholder needs report and strategic research agenda support the strategic thinking and prioritisation of NMIs and DIs, while developing an overall EMN strategy to become a single focal point will increase the value of these technical efforts.

While the dominant societal benefit will arise from improved data availability for climate and oceanographic modellers and the application of these to guide society's response to climate change and the sustainable economic use of the oceans, new opportunities for commercial applications and European job creation will be created. The Copernicus (and similar) services that rely on measurement networks this EMN engages with, support not only climate and oceanographic applications but also the provision of environmental data for services ranging from agriculture to transport, to disaster response (flooding, drought, and forest fires), as well as border and maritime surveillance and security concerns.

List of publications

Woolliams, E, Pascale C, Fisicaro P and Fox, N. "The European metrology network for climate and ocean observation". Proceedings 19th International Congress of Metrology, 05001 (2019). https://doi.org/10.1051/metrology/201905001

This list is also available here: https://www.euramet.org/repository/research-publications-repository-link/

Project start date and duration:	29 April 2019, 60 months	
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Internal Funded Partners: 1. NPL, United Kingdom 2. LNE, France 3. METAS, Switzerland	External Funded Partners:	Unfunded Partners: 4. PTB, Germany 5. SMD, Belgium