EMRP Call 2013 – Energy and Environment

Selected Research Topic number: **SRT-v07**
Version: 1.0

Title: Metrology for oceanographic observables

Abstract

The ocean is a key factor in climate change as it acts as the main global storage and transport system for heat and gases. Seawater is the largest buffer for anthropogenic CO_2: causing ocean acidification and damage to the marine ecosystem. High quality data on thermodynamic and chemical properties of seawater is required to understand fully relevant oceanic parameters which in turn allow accurate modelling and assessment of climate change. This must be underpinned by advanced metrology for relevant ocean variables, including salinity-density-refractive index and pressure-speed of sound relationships, and pH affected chemical equilibria in the carbonate system. New calibration procedures and guidelines for in-field sensors will also be required.

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 23 and 24.

Keywords

Seawater, Salinity, Density, Refractive Index, Speed of Sound, pH, CO_2 Content, Dissolved Oxygen, Nutrients, On-line Sensors, Oceanic Parameters, Temperature, Ocean Acidity

Background to the Metrological Challenges

The Earth's climate is changing in ways that affect our weather, oceans, ecosystems, and society. Climate change and ocean acidification are threatening food security and biodiversity. Ocean and climate are closely related, the condition of one strongly affecting the other. Moreover, ocean salinity changes are a sensitive proxy for a number of climate change processes such as precipitation, evaporation, river run-off and ice melt. Reliable data on the properties and status of the Earth’s oceans is therefore a key factor in the modelling of climate change, the global water cycle, the propagation of ocean acidification and deoxygenation to the ocean interior and assessments for the future of aquaculture and fisheries. The need for improved monitoring of the marine environment and sound databases for the modelling of global change processes is highlighted in various documents. The Marine Strategy Framework Directive 2008/56/EC [1] directly addresses the necessity of achieving a healthy marine environment and of having profound measuring systems to monitor the ocean’s status.

The thermodynamic parameters salinity-density-refractive index and pressure-speed of sound are key parameters for the monitoring and modelling of the ocean currents, its heat uptake, and increases in sea level. In the current EMRP JRP-ENV05 “Metrology for ocean salinity and acidity” basic relationships are being measured by methods traceable to the SI. But there is still a lack of traceability for measurement devices in the field, especially for most on-line measuring devices. Calibration and handling procedures at all measurement stages are required, including the on-line measuring devices used in field. This includes guidelines and recommendations for measuring procedures and reference materials.

Carbonate system variables (e.g. total alkalinity (TA), total dissolved inorganic carbon (DIC), carbon dioxide fugacity (fCO2), and pH) are linked via equilibrium thermodynamics. Thus, these parameters can be either measured directly or calculated by means of other parameters. Differences between measured and calculated parameters may be significant when compared to current uncertainties of analytical measurements. Several reasons have been identified for the lack of reliability of the thermodynamic constants:

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- pH has multiple definitions which can result in multiple values for acid-dissociation constants.
- Different measurement methods are used, which lack metrological traceability. Discrepancies in measurement results and hence comparability problems are a common consequence.
- Dissociation constants reliable for artificial seawater are not appropriate for real seawater.

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 thermodynamic and chemical properties of seawater.

The specific objectives are

1. To develop a metrological platform for field measurements of the following thermodynamic parameters: salinity, density, refractive index and speed of sound measurements, and that allows for the derivation of relationships for salinity-density-refractive index and speed of sound-pressure with reduced uncertainties.
2. To develop a metrological platform for chemical parameters that provides a robust basis for study of the carbonate system and its pH dependency in the marine environment. This should lead to a quantification of equilibrium thermodynamics and dissociation constants of carbonic acid in seawater.
3. To develop standards and simplified calibration methods for sum parameters such as dissolved organic carbon (DOC), dissolved inorganic carbon (DIC), dissolved oxygen (DO) and alkaline macro nutrients like nitrogen and phosphorus, as well as traceable calibration methods and uncertainty estimation for measuring macro nutrients like nitrogen and phosphorus and micro-nutrients like iron.
4. To undertake chemical analysis of the variable seawater constituents (carbonate system and macro nutrients).

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 ENV05 “Metrology for ocean salinity and acidity” 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 (e.g. letters of support) is encouraged.

You should detail how your JRP results are going to:

- underpin and develop European and international regulation or feed into the development of urgent documentary standards through appropriate standards bodies, respectively.
- transfer knowledge to the oceanographic and marine 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.

Additional information

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

[1] Directive 2008/56/EC: Establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)