Publishable JRP Summary Report for JRP ENV05 OCEAN
Metrology for ocean salinity and acidity

The project “Metrology for ocean salinity and acidification” will improve the metrological infrastructure required for a reliable monitoring and modelling of ocean processes. It will cover the thermodynamic quantities salinity, conductivity, density, speed of sound, and temperature, and the chemical quantities pH, oxygen content and composition.

The ocean acts as a sink for carbon dioxide and plays an important role in regulating the global climate system. The dynamics of the ocean and its interaction with the atmosphere are strongly linked to the properties of seawater. Salinity and temperature of seawater are major forces for driving global currents and their spatial circulation patterns. Measurement results in this context are stored in databases of global observation systems and are used for oceanographic and climate change research. These data should be reliable and comparable on multi-decadal to centennial scale.

The project aims to develop methods, standards and tools to improve the databases used for climate models. Measurement standards with well characterized uncertainties will enable calibration of in-situ observing sensor networks and satellite systems traceable to SI units. This will allow scientists to measure more accurately small changes in long-term oceanographic data series.

In work packages one and two the basis for data at higher pressure of up to 70 MPa and in a temperature range between 0 °C and 40 °C for the Equation of State will be improved by measurements of density (relative target uncertainty $1 \cdot 10^{-5}$), salinity (relative target uncertainty $1 \cdot 10^{-4}$) and speed of sound (relative target uncertainty $1 \cdot 10^{-3}$).

A novel primary conductivity sensor which can be used at high pressure will be developed, tested and linked to primary improved density measurements at the same high pressure.

Improved and robust speed of sound measurement data for both high accuracy laboratory and in situ measurements of seawater, will provided by means of an ultrasonic double-reflector pulse-echo overlap technique. This also includes improved temperature measurements with an uncertainty of 5 mK.

These data will provide the oceanographic community with the necessary information to improve the Equation of State in the near future and consequently improve the oceanographic and climate modelling.

Work package three will provide reference procedures and validated measurement methodologies for the determination of seawater acidity and composition; in particular nutrients (nitrates, phosphates, and silicates) and trace elements (iron). Traceability to SI units or internationally accepted references will be established for the measurement results.

Harmonised pH measurement procedures will be provided to underpin the traceability of the pH data of seawater. The development of a primary potentiometric pH procedure at higher ionic strength will allow the characterization of artificial seawater of reference composition which will be suitable as calibration standard for spectrophotometric pH measurements.

A validated method for the quantification of the mass fraction of strontium based on isotope dilution mass spectrometry (ID-ICP-MS) will be developed. Using this primary method, an uncertainty level below 3 %, which will be lower than those obtained with other techniques, is expected. Analytical procedures for the quantification of nutrients in seawater will be developed taking into account matrix contributions.

More accurate methodologies for the determination of iron in seawater will be developed. Confidence in quantification will be achieved by rigorous validation (covering sampling and sample treatment), including thorough uncertainty budgeting and the comparison between shipboard methods and ID-ICP-MS.

EMRP
European Metrology Research Programme
Programme of EURAMET
The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

For the determination of dissolved oxygen, measurement methods will be optimised for the special requirements of seawater. A reduction of the uncertainty by a least a factor of three is anticipated. This work will be done in work package four.

JRP start date and duration:	01 September 2011 for 36 months
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