Proposal for a "Joint SCOR/IAPSO/IAPWS Committee on the Properties of Seawater"

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Background

During the 1960s and 1970s a great deal of fundamental research was carried out on the bulk properties and major constituents of seawater. At the same time, there was a shift away from Chlorinity titration to the use of electrical conductivity as a primary measurement tool for oceanic salinity. A long-standing group, JPOTS (the UNESCO/SCOR/ICES/IAPSO Joint Panel on Oceanographic Tables and Standards), which was constituted from 1964 through to 1990, monitored the state of progress in this area and standardized procedures with the development of a number of standards, culminating in the Practical Salinity Scale 1978 (PSS-78; Unesco, 1981a), the International Equation of State 1980 (EOS-80; Unesco, 1981b), and a standard set of software for computing properties of seawater (Fofonoff and Millard, 1983). The relation between oceanographic measurements and the International System of Units, or SI, was described by the IAPSO Working Group on Symbols, Units and Nomenclature in Physical Oceanography (SUN, 1985).

However, these standards were then basically unexamined in any formal way for the next 25 years. In addition, there was little coordination between oceanographers and the metrological community. 'Salinity' (or more accurately 'Practical Salinity') remains a unit-less oddity in the scientific world.

In contrast, instrumentation technology and operational procedures, developed by large-scale projects such as WOCE, rapidly advanced to allow the calculation of internationally intercomparable in-situ measurements of conductivity to a precision about 5 times greater than had been envisaged by JPOTS. The accuracy of estimates of seawater properties were limited by the theoretical basis of the standards, and not by measurement procedures!

Recently, SCOR/IAPSO Working Group 127 on the Thermodynamics and Equation of State of Seawater (2005-2011) synthesized a great deal of existing research, and added to it to create a new standard for the thermodynamic properties of seawater, the Thermodynamic Equation of Seawater-2010 (TEOS-10; IOC et al., 2010). The new standard provides significant improvements over PSS-78/EOS-80.

However, many fundamental issues regarding the properties of seawater and the way in which we estimate them remain to be addressed. Improving our knowledge of these issues and developing improvements in standard practices will have applications to virtually every oceanographic research project, with outreach to marine technology, industry and climatology. These issues include traceability of calibration procedures to the SI (necessary for long-term climate comparisons, and to maintain compatibility with the rest of the scientific world), development of new algorithms for high and low salinities as well as for high temperatures and pressures (required in sea-ice and industrial applications such as desalination), better characterization of electrical conductivity and other properties such as pH, gas solubility, and refractive index, better understanding of the sources and magnitudes of chemical composition variability in the ocean (which will affect our algorithms), and development of measurement technology for density and other properties. Another indispensable ongoing task is the maintenance of the TEOS-10 standard and its software libraries, and guiding the community in its use.

Although short-term Working Groups are a useful way in which groups of researchers can come

together to solve the kinds of specific problems mentioned above, this process is very much “bottom-up" and the coverage of important issues can be uneven. In addition, such WG are an appropriate way of summarizing, synthesizing, and combining available research, but will not monitor or encourage longer-term projects, nor will it be able to maintain links or liaisons to other standards organizations. However, these kinds of tasks are essential to the health of ocean science.

Proposal: a Joint Committee on the Properties of Seawater

We propose a “permanent” joint committee of SCOR, IAPSO, and IAPWS to act as a point of contact for seawater questions (to be called JCS, Joint Committee of SCOR, IAPSO, and IAPWS on Seawater). It will be jointly sponsored by organizations directly concerned with the properties of seawater, and will act as a permanent source of expertise to the parent organizations, and a conduit for communications to other international organizations like the BIPM and the WMO, or IUPAC. It can summarize present progress to the community at large and suggest areas where gaps exist in the available knowledge. It will maintain a repository of knowledge (e.g., via a web-site).

The committee would consist of a chair and several vice-chairs who would coordinate the work and report to the parent organizations as required. Members would be nominated to the committee based on their participation in relevant Working Groups or operational/research/industrial relevance.

The committee would publish reports from time, summarizing and/or endorsing products of the working groups. In addition, it would assist the working groups in coming up with products useful for the wider scientific and technical community, by facilitating the development of standards.

Every 6 years (i.e. two terms of the executive) the parent organizations should re-approve the terms of reference.

In detail:

Terms of Reference

(1) To act as a 'point of contact' for issues related to the bulk properties of seawater.

(2) To maintain and update documents, websites and software of TEOS-10 and other standards.

(3) To encourage the uptake of TEOS-10 and other standards by the oceanographic community by acting as a source of advice.

(4) To globally coordinate research and the development of standards related to properties of seawater across different scientific communities.

(5) To identify developing needs for standards and encourage research in those areas, through small collaborations, more formal Working Groups, conference sessions, or other avenues.

(6) To issue reports or other documents from time to time on issues relating to the bulk properties of seawater.

(7) To work toward international and interdisciplinary uniformity and consistency of the standards and measurement procedures used in oceanography

Membership

An executive consisting of a chairman and 2 or 3 vice chairs, appointed by the parent organizations for renewable 3 year terms. Members will be appointed by the parent organizations on the advice of the executive, again for renewable 3 year terms.

Budget requirements

Regular, if infrequent, face-to-face meetings of the core participants will be needed when substantive issues need to be decided upon. The annual IAPWS meetings presently provide an appropriate venue for such discussions, although other occasions may also arise. No budget pre-commitments to hold JCS meetings are sought at this stage. Rather a request for funding of a meeting would arise if and when there becomes a clear need to finalize a discussion that has not progressed to completion over email. Working Groups will be handled by parent organizations in the usual way.

A small amount of financial assistance (max $10,000/year) may be requested from SCOR to facilitate the attendance of JCS executive members at important meetings (e.g., those involving the development of formal collaborations between different scientific organizations)

Administrative assistance by one of the parent organizations in maintaining a web presence would be useful to guarantee continuity beyond membership lifetimes. This presence would include a description of the Committee and its members, a permanent email and address, and informational material related to TEOS-10 and other standards directly relevant to ocean science.

Details of Proposed Committee Tasks

The tasks of the committee can be divided into two sets. First, the Level 1 tasks are broad in nature and consist of either ongoing tasks, or important goals which will take a number of years and a broad range of expertise to solve. In contrast, the Level 2 tasks are more immediate short-term research issues, which have been identified as important but can be resolved on a 1-2 year time scale. As these are solved, it is expected that other tasks will follow.

Level 1 Tasks

(1) Develop 'SI traceable' metrological standards and procedures for salinity measurements of Standard Seawater

(2) Develop a conductivity/salinity relationship to cover the entire range of salinities for which TEOS-10 is valid (from 0 g/kg to the point at which calcium carbonate precipitates) (i.e., extend/update PSS-78). From advanced measurements, estimate the potential drift of SSW conductivity relative to PSS-78 over the past decades.

(3) Encourage precision laboratory measurements and experiments with artificial seawater to improve and extend the empirical knowledge on thermophysical properties of seawater, including its chemical composition

(4) Develop extensions or updates of TEOS-10 as soon as sufficient quantities of accurate new experimental data become available.

(5) Develop additional standard formulations for seawater properties such as conductivity, viscosity, pH, refractive index, surface tension, evaporation and freezing rates, nucleation rates, optical transparency or sound speed attenuation, consistent with TEOS-10.

(6) Support studies on less common properties of seawater such as supercooled water at the Antarctic shelf or critical water at hydrothermal vents.

(7) Develop a plan to maintain and extend the TEOS-10 code base and encourage its wide use by being incorporated into commercial and research products also beyond oceanography.

(8) Assist in the adoption of TEOS-10 and other standards, as they are developed, by the oceanographic community.

(9) Encourage and support the use of TEOS-10 and related standards in meteorology, polar sciences and climatology.

(10) Recommend, on an occasional but continuing basis, to IAPSO that they continue to approve IAPSO standard seawater, requiring periodically reviewed preparation methods and the support of new methods of traceability to the SI.

(11) Develop a better understanding of the composition variations in the ocean (e.g., Ca++ and SO4--, and the marine carbon and silicate systems).

(12) Support the development of stable and reproducible standards for marine pH measurement.

(13) Accompany and support the development of new CTD sensors such as for density, refractive index or pH, for example by the issue of Certified Research and Development Needs.

(14) Develop a metrological practice for systematic and regular estimates of uncertainties for oceanographic observations, archived data and numerical models, consistent with SI requirements.

Level 2 tasks

(1) Characterize the effects of dissolved organic matter (DOM) on density.

(2) Resolve outstanding issues on ageing and batch-to-batch variability in conductivity and density of Standard Seawater.

(3) Encourage direct measurements of density anomalies in different oceans and adjacent seas and run intercalibration exercises.

(4) Re-evaluate the algorithm for Salinity Anomalies after 5 years.

(5) Write a 'best practices' document on density measurement.

(6) Describe the uncertainty of properties computed from TEOS-10.

(7) Support the development of industrial formulations based on TEOS-10 (usually, simplified correlations with reduced accuracy or range of applicability).

(8) Review solubility of gases in seawater, and their effects on density and other properties.

(9) Characterize the effects of using TEOS-10 (and in particular salinity anomalies) relative to EOS80.

(10) Encourage measurements at high salinities and temperatures, and at high pressures.

(11) Develop better numerical models for density, electrical conductivity, and other properties of natural waters.

(12) Quantify effects of composition variations on the overturning circulation.

(13) In intended cooperation with BIPM, prepare an updated document "The International System of Units (SI) in Oceanography", replacing the obsolete IAPSO/SUN document of 1985.

(14) Develop links with Chinese oceanographers and their own primary calibration standard, Chinese SSW

References

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