

# Report on activities of the SCOR/IAPWS/IAPSO Joint Committee on the Properties of Seawater (JCS)

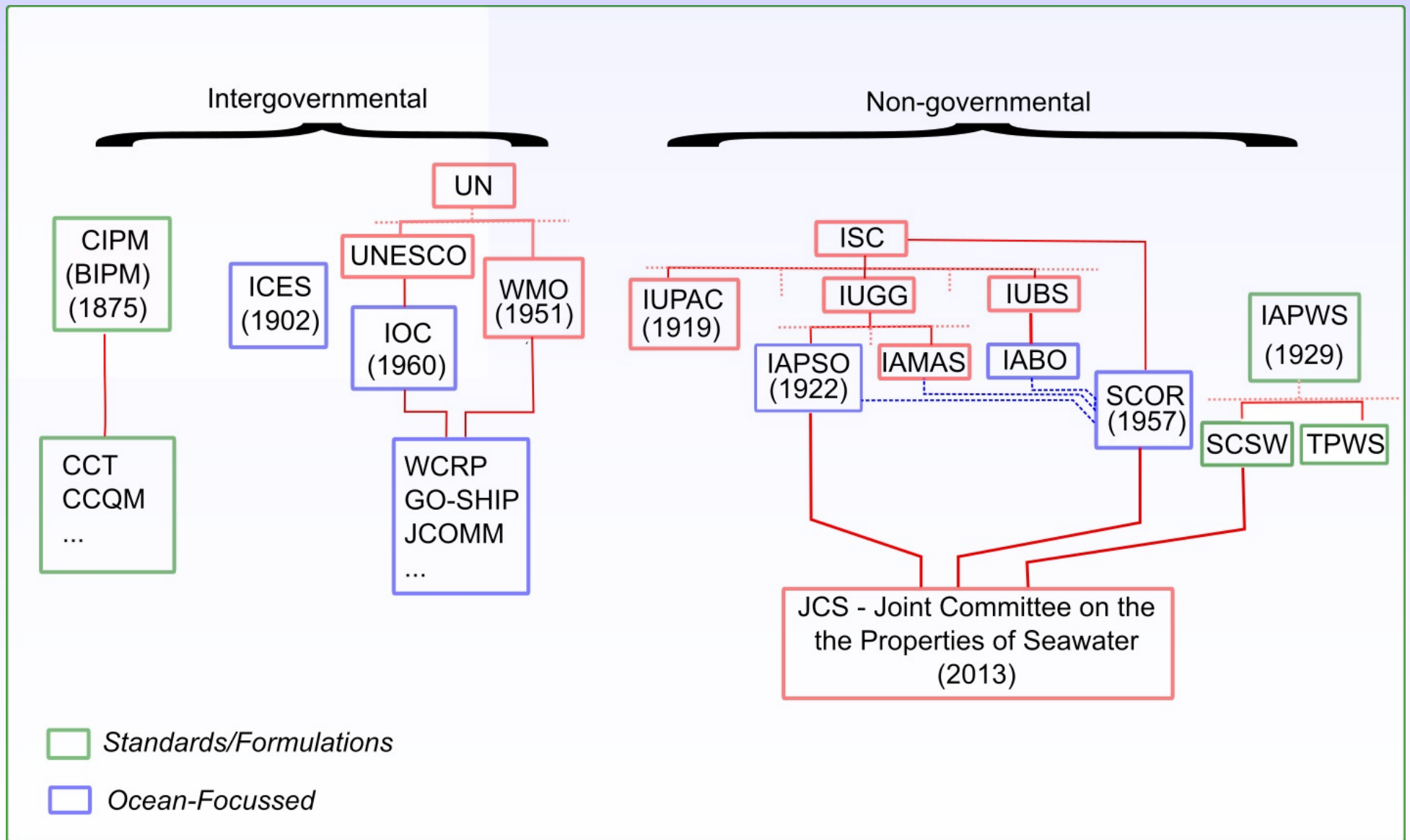
Rich Pawlowicz  
Chair, JCS  
*University of British Columbia  
Vancouver, Canada*

# Purpose of JCS

- JCS is meant to act as:
  - an “international point of contact” for seawater-related questions
  - a permanent source of expertise on seawater issues for “parent” organizations
  - the maintainers of seawater-related software and standards for the scientific community (especially for **TEOS-10**)
  - a conduit for cooperation with other scientific/technical organizations, e.g., BIPM, WMO, IUPAC
- JCS supports and promotes research activities related to the properties of seawater (field, lab, numerical)
- JCS may, from time to time, summarize knowledge and suggest gaps

Terms of Reference set in  
2013, reaffirmed in 2018

# JCS and its parents



Relationship with IAPWS  
currently in discussion

# JCS Structure (2023)

- **Executive**

- Chair: R. Pawlowicz, Vice Chairs: S. Seitz

- **Taskgroups:**

- **Salinity/Density**

- Chair: (Pawlowicz), (Seitz), H. Uchida, R. Woosley, Y. Kayukawa

- **pH**

- Chair: A. Dickson, M.F. Camoes, D. Stoica, S. Clegg, F. Bastkowski

- **Moist Air**

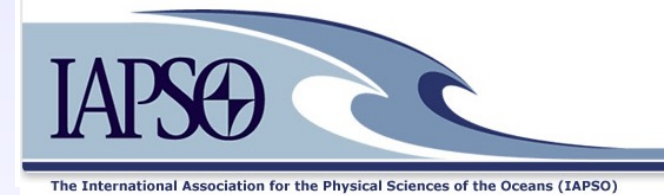
- Chair: O. Hellmuth, J. Lovell-Smith, R. Feistel, S. Bell

- **Chemical Speciation**

- Chair: D. Turner, (S. Clegg), P. Croot, C. Foti, M. Gledhill, M. Hain, P. Lodeiro, S. Sander

- **Expert Subgroups**

- **Thermodynamics** (Feistel)
- **Numerical modelling and applications** T. McDougall
- **Software** (vacant)
- **Industry** C. Bachler/Anton Paar, R. Williams/OSIL



(24 members: Canada/US, Germany/Portugal/France/UK/Austria, Australia/NZ, China/Japan)

- New addition – Chemical Speciation Taskgroup (from SCOR WG 145)
- Several members have rotated off/retired; most problematic has been responsibility for software (incl. TEOS-10 website)

# TEOS-10 related activities:

## Web site [www.teos-10.org](http://www.teos-10.org)

- **Software:**
  - GSW (8 languages), SIA (2 languages)
- **Educational resources:**
  - Slides
  - TEOS-10 Primer
  - Full course on thermodynamics
  - 2 lecture overview of seawater thermodynamics
- JCS news (annual reports)
- JCS membership
- List of Publications (relevant to definition of TEOS-10)

**TEOS-10**  
Thermodynamic Equation Of Seawater - 2010

**MENU**

- Home
- Publications
- Software
- Educational resources
- JCS news
- About JCS
- About WG127
- Contact us

**HOME**

This site is the official source of information about the Thermodynamic Equation Of Seawater - 2010 (TEOS-10), and the way in which it should be used.

TEOS-10 is based on a Gibbs function formulation from which all thermodynamic properties of seawater (density, enthalpy, entropy sound speed, etc.) can be derived in a thermodynamically consistent manner. TEOS-10 was adopted by the Intergovernmental Oceanographic Commission at its 25th Assembly in June 2009 to replace EOS-80 as the official description of seawater and ice properties in marine science.

A significant change compared with past practice is that TEOS-10 uses Absolute Salinity  $S_A$  (mass fraction of salt in seawater) as opposed to Practical Salinity  $S_P$  (which is essentially a measure of the conductivity of seawater) to describe the salt content of seawater. Ocean salinities now have units of g/kg.

Absolute Salinity (g/kg) is an SI unit of concentration. The thermodynamic properties of seawater, such as density and enthalpy, are now correctly expressed as functions of Absolute Salinity rather than being functions of the conductivity of seawater. Spatial variations of the composition of seawater mean that Absolute Salinity is not simply proportional to Practical Salinity; TEOS-10 contains procedures to correct for these effects.

The document [What every oceanographer needs to know about TEOS-10 \(the "TEOS-Primer" for short\)](#) is a concise summary of the salient theoretical concepts which underpin TEOS-10, while [Getting started with the GSW Oceanographic Toolbox](#) of TEOS-10 guides the user through the steps required to process and publish physical oceanographic data using TEOS-10. A detailed explanation of the TEOS-10 thermodynamic description of seawater can be found in the [TEOS-10 Manual](#) which has been published by IOC, SCOR and IAPSO. Note that a pdf version of TEOS-10 Lecture Slides is located on the publications page.

**Importantly, while Absolute Salinity (g/kg) is the salinity variable that is needed in order to calculate density and other seawater properties, the salinity which should be archived in national data bases continues to be the measured salinity variable, Practical Salinity (PSS-78). To avoid confusion while the use of Practical Salinity in scientific publications is phased out, published values of salinity should be specifically identified as being either Practical Salinity with the symbol  $S_P$  or Absolute Salinity with the symbol  $S_A$ .**

Links at left provide more detailed information about publications describing the new approach, and computer codes that implement it.

**SCOR**  
Scientific Committee on Oceanic Research

**IAPSO**  
International Association of Pure and Applied Seawater Oceanography

**UNESCO**  
United Nations Educational, Scientific and Cultural Organization

**IOC**  
International Oceanographic Commission

DISCLAIMER

Designed by Paul Barker & Anoush Sarraf

- Web site contents remain stable, but future not clear

# TEOS-10 related activities: Web site [www.teos-10.org](http://www.teos-10.org)

Unique downloads:	June 2011 June 2013	June 2013 June 2014	June 2014 June 2015	June 2015 June 2016	June 2016 June 2017	June 2017 June 2018	June 2018- Apr 2019	May 2019- May 2020	May 2020- June 2021	June 2021- June 2022	June 2022- June 2023
Manual	920	360	535	552	418	427	349	472	479	482	530
"Getting Started"	879	362	558	547	427	475	349	444	460	483	479
Slides	704	284	374	318	219	248	204	272	272	231	272
Primer	584	197	289	297	222	217	187	253	260	226	268
Lecture Notes								22	34	30	27
Thermo Overview								24	27	27	23
GSW MATLAB	1920	1102	1485	1814	1235	1552	1233	1556	1504	1747	1897
GSW FORTRAN	366	222	171	162	127	116	82	98	83	92	87
GSW C	202	84	133	151	85	96	59	81	58	49	57
GSW PHP	-	55	61	43	29	60	28	52	22	22	21
SIA VB	72	100	46	45	45	48	43	47	47	38	30
SIA FORTRAN	59	118	58	44	36	42	37	42	31	33	31

- 87397 "unique user views" since Oct 2010 (10753 in past year)
- 750-1300 views per month

Click to open the TEOS-10 Getting Started (pdf)

Click to open the TEOS-10 Primer (pdf)

Click to open the TEOS-10 teaching aid slides(powerpoint)

you **MUST** add all the SUBFOLDERS to the PATH, then you **MUST** run "gsw\_check\_functions". See [Installation instructions](#) below for the complete installation instructions.

Installation instructions

Getting started

GSW version history

Licence

GSW v3.06 (MATLAB)

Download

GSW v3.05 (C)

Download

GSW v3.05 (C++)

Download

GSW Toolbox contents

GSW Toolbox list (Printable)

GSW Toolbox list (Basic functions)

SW to GSW conversion table

GSW v3.05 (FORTRAN)

Download

GSW v3.03 (PHP)

Download

GSW v3.05 (JULIA)

Link

**python**

The Python version is developed at [github.com/TEOS-10/GSW-Python](https://github.com/TEOS-10/GSW-Python), from which the latest source code can be downloaded. For most users, however, using a conda-based Python distribution ([miniconda](#), or [Anaconda](#)) is highly recommended. The conda-forge channel provides the latest release, installable with a simple command:

```
conda install -c conda-forge gsw
```

**R**

R users can access TEOS-10 algorithms through the gsw package. This package is hosted on the [Comprehensive R Archive Network](#), and so it is installed within R itself, by typing

```
install.packages('gsw')
```

In an R session. The current gsw version (1.0-5) is based on gsw-c version 3.0-5 (git commit 5b4d959e54031f9e97273e863f63e67fa4f5bfec at [github.com/TEOS-10/GSW-C](https://github.com/TEOS-10/GSW-C)). The [CRAN gsw web page](#) provides check results, an issue tracker, a reference manual, a vignette, and a link to a supplemental webpage at [teos-10.github.io/GSW-R/index](https://teos-10.github.io/GSW-R/index).

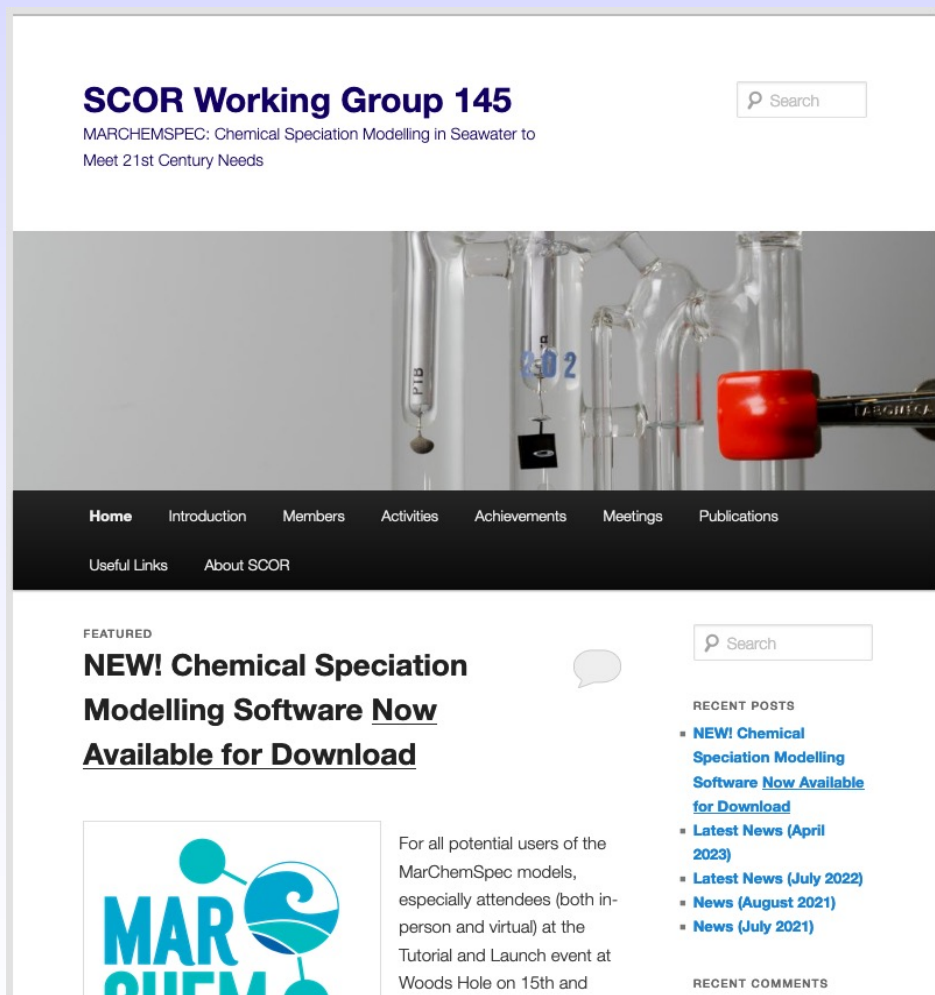
If you have any questions regarding the software listed on this page email [help@TEOS-10.org](mailto:help@TEOS-10.org)

The GSW toolbox has been developed in Matlab. It is currently being translated into other languages, if you wish to see the current progress or wish to participate in translating the code visit the development repository at [http://www.github.com/TEOS-10](https://www.github.com/TEOS-10)

- Uploads of GSW and the manual have increased over the last year
- EXCEL implementation has been implemented by 3<sup>rd</sup> parties



# Other web activity in progress...



- Website development for chemical speciation software (now live) and for JCS (soon to be live, once hosting issues solved)

# Recent meetings

- No in-person meetings of JCS occurred over the past year. A planned JCS virtual meeting for January 2023 was postponed, and a possible meeting at the 2023 IAPWS Annual Working Group Meeting did not occur. However, the proposed membership of the new Chemical Speciation Taskgroup has been finalized and they have been holding regular (monthly) virtual meetings as part of software finalization from the completion of SCOR WG 145, and the development of a website containing that software.
- Considering plans for in-person meeting in 2024 or 2025 to reconsider Terms of Reference (3<sup>rd</sup> iteration).



# Recent papers

- 1) M.P. Humphreys, J.F. Waters, D.R. Turner, A.G. Dickson and S.L. Clegg. Chemical speciation models based upon the Pitzer activity coefficient equations, and including the propagation of uncertainties: Artificial seawater from 0 to 45 °C. *Marine Chemistry*, 244, 104095. doi: <http://dx.doi.org/10.1016/j.marchem.2022.104095>
- 2) S.L. Clegg, M.P. Humphreys, J.F. Waters, D.R. Turner, and A.G. Dickson. Chemical Speciation models based upon the Pitzer activity coefficient equations, including the propagation of uncertainties. II. Tris buffers in artificial seawater at 25 °C, and the seawater 'Total' pH scale. *Marine Chemistry*, 244, 104096. doi: 10.1016/j.marchem.2022.104096
- 3) S.L. Clegg, J.F. Waters, D.R. Turner, and A.G. Dickson. Chemical speciation models based upon the pitzer activity coefficient equations, including the propagation of uncertainties. III. Standard seawater from the freezing point to 45 °C, including acid-base equilibria, *Marine Chemistry*, 250, 104196. doi: 10.1016/j.marchem.2022.104196
- 4) R. Feistel, O. Hellmuth, and J. W. Lovell-Smith (2022) Defining relative humidity in terms of water activity. Part 3: Relations to dew-point and frost-point temperatures, *Metrologia*, 59 (4), <https://doi.org/10.1088/1681-7575/ac7185>
- 5) R. Feistel and O. Hellmuth, (2023), Thermodynamics of Evaporation from the Ocean Surface, *Atmosphere* 14, 560, <https://doi.org/10.3390/atmos14030560>
- 6) Uchida, H., M. Oe and M. Wakita (2023): History of batch-to-batch comparative studies of International Association for the Physical Sciences of the Oceans Standard Seawater, Chapter 7 in Chemical reference materials of ocean science: history, production, certification and current status, Akihiko Murata and Cheong Chikako (eds.), Springer, (in press)
- 7) Uchida, H., M. Wakita, A. Makabe, A. Murata, Changes in the Composition of International Association for the Physical Sciences of the Oceans Standard Seawater, Chapter 8 in Chemical reference materials of ocean science: history, production, certification and current status, Akihiko Murata and Cheong Chikako (eds.), Springer, (in press)
- 8) Christoph Waldmann, Philipp Friedrich Fischer, Steffen Seitz, Manuela Köllner, Jens-Georg Fischer, Markus Bergenthal, Holger Brix, Stefan Weinreben and Robert Huber, A Methodology to Uncertainty Quantification of Essential Ocean Variables, *Frontiers in Marine Science* 15, 2022, Sec Ocean Observation, Vol 9, 2022, <https://doi.org/10.3389/fmars.2022.1002153>