Ocean Science Discussions

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Reply on CC1

Carlos Gil Martins and Jaimie Cross

Author comment on "Technical note: TEOS-10 Excel – implementation of the Thermodynamic Equation Of Seawater – 2010 in Excel" by Carlos Gil Martins and Jaimie Cross, Ocean Sci. Discuss., https://doi.org/10.5194/os-2022-2-AC4, 2022

Richard Pawlowicz comments are included below in plain text, followed by the authors reply in **bold**.

The authors have developed an Excel spreadsheet with VBA macros that implements a small subset of the TEOS-10 software library available as the Gibbs Seawater (GSW) toolbox.

This is a great thing to have around, and something that has been on a 'wish-list' by the Joint Committee on the Properties of Seawater (JCS) for a long time.

In general, I would be happy to see this published. But I do have some concerns, as well as minor corrections.

1) My first concern is related to the fact that only a small subset of GSW is implemented.

Obviously the whole tooblox is immense and (mostly) not needed, but I suggest adding a table to the paper listing exactly which GSW functions are implemented in macros. I could puzzle this out by opening up the macros (and sections 3.1-3.13 cover this material), but this information is then scattered over many pages.

From the outset, our objective was not to develop a full Excel implementation of the GSW toolbox. We welcome your suggestion, however, and we will add a table listing all VBA modules (table attached to our Author's post https://doi.org/10.5194/os-2022-2-AC3).

2) Also I note that what you apparently call 'SP_from_C' is not at all gsw_SP_from_C. I see from your reply to an earlier comment that you want to 'leave this for the future', about which I am not really very enthusiastic. I'd rather this was fixed now, as it is unlikely that a future software update will be matched with a future documentation update like this paper.

Part of my reasoning for suggesting this get fixed now is that I can see an important audience for this EXCEL sheet are limnologists, many of whom are not very computational, but may want to see if TEOS-10 will help them. However, for them the low-

frequency correction is pretty important.

The $0 < S_P < 2$ correction has now been included in version 2.0 (see our author's post). The former 'SP_from_C' function included was replaced by a direct translation of the GSW counterpart.

3) So, in particular, I think you need to note explicitly in the text that the practical-salinity-from-conductivity algorithm is NOT as in GSW, and exactly
how it is different.

As per the comment above, we are confident that the practical-salinity-from-conductivity algorithm is now the same.

4) This point is less of a concern with the work itself rather than a suggestion. I can see that one very useful target audience for this are people (e.g., lab technicians) using salinometers, as they are much more likely to be familiar with EXCEL than with programming languages. A salinometer does not actually calculate the conductivity, instead it calculates a conductivity ratio (see gsw_SP_salinometer), which should then be the 'entry point' into calculations.

I urge you to consider adding this functionality - perhaps in another tab somewhat like the 'surface data' tab but which takes salinometer readings.

Thank-you for highlighting this. The Practical Salinity from the conductivity Ratio is now included in v2.0.

5) I am not sure how difficult this is, but in many cases it is actually useful to set the salinity anomaly to zero and essentially use Reference Salinity to compute density. In many coastal areas, for example, the look-up table is not at all accurate as it contains no information on river salts, and so it's probably better to ignore anomaly calculations completely. This is also true for inland waters. One might, for example, set up the sheets to do this if no Lat/Long is entered, or if some explicit value (e.g., 999) is entered.

This has now been fixed. Leaving the Lat/Long cells empty will set the salinity anomaly to zero, Absolute Salinity = Reference Salinity, with all other parameters estimated.

Minor points:

L8 "in EXCEL to estimate Absolute Salinity...."

(also note that TEOS-10 definitions like Absolute Salinity, Conservative Temperature, etc. should be capitalized - I think this is just repeating an earlier comment.)

Yes, thank you, we will correct this.

L27 "to facilitate the efficient calculation of the properties...."

Noted and accepted.

L30-33: the GSW software is available in many programming languages other than MATLAB, so your statement is not quite correct. However, it is true that many practitioners might not be familiar with ANY programming language, so this EXCEL implement is definitely fulfilling a need.

Thank-you for highlighting this. The text has been changed to:

...implements the Thermodynamic Equation of Seawater – 2010 (TEOS-10) into software that calculates required seawater properties through the utilisation of programming languages (e.g., MATLAB, FORTRAN, C) that require a working understanding and knowledge of computer programming.

L42-44. It is NOT CORRECT that the properties related to the chosen variables (salinity, temperature, and pressure) must be conservative for thermodynamics to apply. In fact, they are not! It is certainly useful for numerical modelling purposes if chosen variables can be written in such a way that they are conservative under mixing, but this has nothing to do with the thermodynamic state of the fluid itself. In fact, the choice of S/T/p as state descriptions is useful in that these are measurable variables and are natural for a Gibbs function description of the state.

This sentence should probably be removed.

Thank-you for correcting this. The sentence in question has been removed from the manuscript.

L46: this is a little trivial, but temperature standards have also changed over time - before IPTS-68 there were a number of other standards - so it is not true that the concept has remained 'unaltered over time'.

As measurement technologies advance and our understanding of the oceanic environment evolves, standards relating to physical parameters frequently change in response. The definition of salinity has undergone several variations during the last century (Millero, 2010) and the temperature standard changed in 1989 from IPTS-68 to ITS-90 (Preston-Thomas, 1990).

L47-48. Technically, absolute salinities (lower case) are mass fraction definitions. However,
Absolute Salinity S_A (capitalized as defined in TEOS-10) is actually "the mass fraction of dissolved material in Reference Composition Seawater of the same density as that of the sample" (it is in fact a density salinity). Yes, this is complicated and confusing.

Thank-you for pointing this out. We have incorporated this correction into the revised sentence, as follows:

The current Thermodynamic Equation Of Seawater - 2010 (TEOS-10) has introduced a new salinity quantity, Absolute Salinity (S_A), defined as "the mass fraction of dissolved material in seawater" (IOC, SCOR and IAPSO, 2010: 3); however, Absolute Salinity is arguably more accurately defined as the mass

fraction of dissolved material in Reference Composition Seawater of the same density as that of the sample (Wright et al., 2011).

Wright, D. G., Pawlowicz, R., McDougall, T. J., Feistel, R., and Marion, G. M.: Absolute Salinity, ''Density Salinity'' and the Reference-Composition Salinity Scale: present and future use in the seawater standard TEOS-10, Ocean Sci., 7, 1–26, https://doi.org/10.5194/os-7-1-2011, 2011.

L53: S_A and CT are natural arguments into a simpler and more computationally efficient 75-term density/specific volume equation by Roquet et al. (2015), which can be used to derive some (but not all) other thermodynamic properties, although the best reference is still the TEOS-10 Gibbs function.

Our intention is to inform that SA and CT are the arguments to be used in the estimation of the other thermodynamic properties. As such, we are confident that the following sentence adequately explains this:

These two new quantities, S_A and Θ, together with pressure (p), are now the arguments of the equation of state, and to compute any thermodynamic property of seawater (e.g., density, sound speed) they must be estimated first.

L101: Maybe clarify that pressure is "sea pressure, i.e. absolute pressure - 10.1325 dbar".

We will add:

For what concerns seawater properties, pressure is always the pressure of the water column, i.e., absolute pressure subtracted by atmospheric pressure. Therefore, at the surface, p = 0. For the upper ocean, 10 dbar ≈ 10 m.

L203: the [Alt-F11] is probably a Windows-specific command. It doesn't work for Excel on Macs.

This is also referred in L77.

L77:

Pressing [Alt + F11] (Windows) or [Fn + Alt + F11] (Mac) opens the VBA environment allowing access to the 15 function modules (table 1), although access to these is not required to make use of the Workbook, nor is a working knowledge of VBA.

L203:

As referred before, access to the VBA project environment can be obtained by pressing [Alt + F11] (Windows) or [Fn + Alt + F11] (Mac). All functions (alphabetically listed in table 1) are described next, following the spreadsheet's column sequence.

L210: It is not exactly true that the conductivity of SSW at standard conditions is 42.9140 mS/cm. This is in fact a number which a) has never been replicated, and b) is more

accurate than we can realistically measure conductivity. So, it is perhaps more true to say that the software is designed so that by definition the conductivity of Reference Composition Seawater with S_P=35 is 42.9140 mS/cm at standard conditions.

Thank-you for this observation. We agree, so the sentence has been rephrased to:

For reference, the calculation algorithm is designed so that the conductivity of Reference Composition Seawater at S_P = 35, t_{68} = 15, p = 0 is 42.9140 mS cm^{-1}, which can be used to validate the function.