Ocean Science Discussions

Ocean Sci. Discuss., author comment AC1
https://doi.org/10.5194/os-2022-2-AC1, 2022

Reply on RC1

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-AC1, 2022

The Reviewer comments are included velow in plain text, followed by the authors reply in **bold**.

Review of "Technical note: TEOS-10 EXCEL – Implementation of the Thermodynamic Equation Of Seawater – 2010 in EXCEL" by Carlos Gil Martins and Jaimie Cross.

This technical note describes the implementation of TEOS-10 software in Excel. Most of the software implemented is from the GSW toolbox (McDougall and Barker, 2011), however the authors opted to adopt their own version of interpolation to compute the Absolute Salinity Anomaly Ratio that is used in the calculation of Absolute Salinity.

The note is well written and contains sufficient detail to inform the reader what it contains and how to use the software.

Many thanks for your comment, we are pleased to hear this.

General point

Note that the correct capitalisation is Absolute Salinity, Practical Salinity, Reference Salinity and Conservative Temperature.

We have now corrected this along the manuscript (capitalising and removing the italics). We applied the same to Absolute Salinity Anomaly and to Absolute Salinity Anomaly Ratio. Other physical parameters (e.g., pressure, density) were also unitalicized but not capitalised.

Detailed points.

Line 46

Delete "If"

'If' at the beginning of sentence has been deleted and 'but' added in Line 47. The corrected sentence is as follows:

The concept of pressure and temperature have remained pretty much unaltered

over time (although the temperature standard changed in 1989 from IPTS-68 to ITS-90 (Preston-Thomas, 1990)), but the definition of salinity has suffered significative variations during the last century (Millero, 2010).

Line 54

The subscript P in S_P should not be italic.

Corrected. All other instances of S_P have also been corrected.

Line 60 (also applies to line 11)

The estimation of Absolute Salinity in the GSW is done through a look-up table but it can be measured directly with the aid of a densimeter.

We accept the suggestion, although we have rewritten this in a slightly different way (below), to include a further modification, driven by your following comment.

Line 61

Direct measurement of Absolute Salinity can be made with the aid of a densimeter (IOC, SCOR and IAPSO, 2010: 82), but in GSW it is estimated from interpolation of measured Absolute Salinity Anomalies stored in a world atlas look-up table. This difficulty might be a possible explanation for the absence of any previous application of TEOS-10 in EXCEL, except for a tool (GSW_Sys_v1.0.xlsm)[1] cited in Jiang et al. (2022). That implementation of the GSW however, does not include the atlas look-up tables, using constant values of Absolute Salinity Anomaly across the major oceanic basins. We have tested this EXCEL tool, using the two data sets included in TEOS-10 EXCEL (TEOS-10 Test Data and TS-55) and, for both data sets (NW Pacific and NE Atlantic respectively), there were differences on the estimation of Absolute Salinity, starting at the 4th decimal place (positive and negative). As discussed in Sect. (3.), the results from TEOS-10 EXCEL are the same, for every parameter (up to 15 decimal places), as the ones obtained with the GSW toolbox.

[1] https://github.com/dpierrot/GSW_Sys

Line 11 edit:

Absolute Salinity can be directly measured with the aid of a densimeter (IOC, SCOR and IAPSO, 2010: 82), but in TEOS-10 its estimation relies on the interpolation of data from casts of seawater from the world ocean (IOC, SCOR and IAPSO, 2010),

Line 61

TEOS10 for excel is included in Jiang et al (2022).

We have addressed this above.

I am not sure if the authors are aware that there is a Visual Basic version of Seawater-Ice-Air (SIA) library which includes some of the GSW functions. The SIA software is available from http://www.teos-10.org/software.htm#2

We were aware, but our initial motivation was in trying to implement the look-up

tables in EXCEL, something that had not been done before. We then continued, translating the necessary functions from MATLAB. It perhaps would have been easier to use some of the above!

Lines 114– 115

The temperature acronym for temperature 68 appears as ITS-68 it should be IPTS-68.

A typo that has been corrected.

Line 130

If the data is not in the ocean then the Absolute Salinity value returned should be equal to the Reference Salinity, then the other values can be computed.

Apologies, we're not sure what you mean here - if coordinates are on land (probably a user input mistake), then there would be no need to compute any parameters; however, we suspect this may not be what you are asking! We are happy to try and address your comment with some clarification.

Section 2.4 SA-CT diagram

Looking at the code, I think the sigma contour that is being plotted is sigma0. Section 3.10 confirms this, σ_0 is generally the standard notation for sigma0.

Sigma-t ($\sigma_t = (\rho\ (S_A,t,0) - 1000$ kg m^{-3}) has been traditionally the standard oceanographic notationfor density for a parcel of seawater not considering pressure (i.e., p = 0 dbar). The "Recommended Symbols and Units in Oceanography" (table L.1, pg. 167 of the TEOS-10 Manual) are σ_2 for a reference pressure of 2000 dbar, σ_4 for a reference pressure of 4000 dbar, but for p = 0 dbar it maintains the index 't', not 0, although having it as superscript (σ^t) instead of the traditional subscript.

In the SA-CT diagram we have represented the density field with sigma calculated from Conservative Temperature instead of temperature ($\rho\ (S_A,\Theta,0) -$ 1000 kg m^{-3}) for consistency with the $S_A - \Theta$ diagrams, and our opinion is that σ_Θ should be the correct symbol as an indication that Conservative Temperature was used (and not temperature). We have now realised, though, that the correct quantity should be 'Conservative density anomaly' (to be distinguished from 'Potential density anomaly' which uses potential temperature as input), so we will replace 'Potential' by 'Conservative' in Sect. 3.10 and in the Abstract (L 9 "conservative density (σ_Θ)"). Note that this quantity (conservative density) is not listed or mentioned in the TEOS-10 manual.

Section 3.1 SP_from_C

It would be great to include the low salinity (0 -2) extension to this function that is included in the GSW version of this software.

Many thanks for your suggestion, we agree. We will include in the manuscript a new section (Sect 2.6) regarding future software updates:

2.6 Version updates

Next version of TEOS-10 EXCEL (version 1.1, in development) will include an additional spreadsheet tab listing all released versions and the respective

applied updates. Some improvements already identified and planned to be incorporated are:

- **Practical Salinity from conductivity function: inclusion of the low salinity (0-2) extension available in GSW.**
- **GSW does not perform interpolation for grids spanning the Pacific Ocean and the Gulf of Mexico, across the Panama Canal. This is not dealt with in the current version but will be addressed in version 1.1.**
- **An additional column for depth (m) will be included in the data spreadsheets and functions for converting pressure to depth and vice-versa will be included, allowing the alternative input of pressure or depth.**

Section 3.3.1 Interpolation

Do you ensure that no interpolation occurs for the grids the span the Pacific Ocean and the Gulf of Mexico, across the Panama Canal?

As per our answer to the previous comment, we acknowledge that this is not addressed by the current version but will be corrected in the next version.

Section 3.3.2

It would have been great if you let the McDougall and Barker know about the missing values in the lookup table. I know that they would be eager to correct this.

Having the look-up tables as EXCEL spreadsheets turns to be a fantastic way of looking at the data and visually detect where the missing values are. This makes browsing the two look-up tables [deltaSA_ref] and [SAAR_ref] and locating gaps in the data much easier. The grid location of each column and depth bin (spreadsheet lines) is described in Sect. 2.5.

References

Jiang L-Q, Pierrot D, Wanninkhof R, Feely RA, Tilbrook B, Alin S, Barbero L, Byrne RH, Carter BR, Dickson AG, Gattuso J-P, Greeley D, Hoppema M, Humphreys MP, Karstensen J, Lange N, Lauvset SK, Lewis ER, Olsen A, Pérez FF, Sabine C, Sharp JD, Tanhua T, Trull TW, Velo A, Allegra AJ, Barker P, Burger E, Cai W-J, Chen C-TA, Cross J, Garcia H, Hernandez-Ayon JM, Hu X, Kozyr A, Langdon C, Lee K, Salisbury J, Wang ZA and Xue L (2022) Best Practice Data Standards for Discrete Chemical Oceanographic Observations. Front. Mar. Sci. 8:705638. doi: 10.3389/fmars.2021.705638

Reference added in the required OS format:

Jiang L.-Q., Pierrot D., Wanninkhof R., Feely R.A., Tilbrook B., Alin S., Barbero L., Byrne R.H., Carter B.R., Dickson A.G., Gattuso J.-P., Greeley D., Hoppema M., Humphreys M.P., Karstensen J., Lange N., Lauvset S.K., Lewis E.R., Olsen A., Pérez F.F., Sabine C., Sharp J.D., Tanhua T., Trull T.W., Velo A., Allegra A.J., Barker P., Burger E., Cai W.-J., Chen C.-T.A., Cross J., Garcia H., Hernandez-Ayon J.M., Hu X., Kozyr A., Langdon C., Lee K., Salisbury J., Wang Z.A., and Xue L.: Best Practice Data Standards for Discrete Chemical Oceanographic Observations. Front. Mar. Sci. 8:705638. https://doi.org/10.3389/fmars.2021.705638, 2022.

McDougall, T.J. and Barker, P.M. (2011) Getting started with TEOS-10 and the Gibbs Seawater (GSW) Oceanographic Toolbox, 28pp., SCOR/IAPSO WG127, ISBN 978-0-646-55621-5,

This reference was already included in the original manuscript.