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Absolute Salinity and TEOS-10: Sea-Bird's Implementation Plans

In June 2009, a new Thermodynamic Equation of State of Seawater, referred to as TEOS-10, was adopted by the Scientific Committee on Oceanic Research (SCOR) and the International Association of Physical Sciences of the Ocean (IAPSO) Working Group 127 (WG127) (McDougall et al., 2009A). The new equation incorporates a more accurate representation of salinity known as Absolute Salinity. The main justification for preferring Absolute Salinity over the most recent salinity definition, Practical Salinity, is that the thermodynamic properties of seawater are directly influenced by the total mass of dissolved constituents (Absolute Salinity). However, the mass of dissolved constituents are regionally variable and are not always accurately represented when using conductivity measurements of seawater, the key parameter used in the calculation of Practical Salinity.

An algorithm is available that allows an estimate of Absolute Salinity to be expressed in terms of Practical Salinity (McDougall et al., 2009B). This paper provides an excellent discussion of Absolute Salinity, TEOS-10, and both theoretical and practical considerations of these quantities. However, mature development of the algorithm requires ongoing comparisons of the density calculated from Practical Salinity to the true density measured in the laboratory across the world's oceans. Therefore, accurate calculations of Absolute Salinity are currently limited by the number of real observations, making the valuation of the composition of regional oceanic waters an evolving process.

The WG127 concluded "there are three very good reasons for continuing to store Practical Salinity rather than Absolute Salinity in [such] data repositories." (excerpt from McDougall et al., 2009A, from Page 7).

- "First, Practical Salinity is an (almost) directly measured quantity whereas Absolute Salinity (the mass fraction of sea salt in seawater) is generally a derived quantity. That is, we calculate Practical Salinity from measurements of conductivity, temperature, and pressure, whereas to date we derive Absolute Salinity from a combination of these measurements plus other measurements and correlations that are not yet well established. Calculated Practical Salinity is preferred over the actually measured in-situ conductivity value because of its conservative nature with respect to changes of temperature or pressure."
- "Second, it is imperative that confusion is not created in national data bases where a change in the reporting of salinity may be mishandled at some stage and later be misinterpreted as a real increase in the ocean's salinity. This second point argues strongly for no change in present practice in the storage of Practical Salinity S_p in national data bases of oceanographic data."
- "Thirdly, the algorithm for determining the "best" estimate of Absolute Salinity is immature and will undoubtedly change in the future so we cannot recommend storing Absolute Salinity in national data bases. Storage of a more robust intermediate value, the Reference Salinity would also introduce the possibility of misuse of salinity data without providing any real advantage over storing Practical Salinity so we also avoid this possibility."

"Data stored in national and international data bases should, as a matter of principle, be measured values rather than derived quantities. In this way we [WG127] continue to recommend the storage of measured (in situ) temperature rather than the derived quantity, potential temperature. Similarly, we strongly recommend that Practical Salinity S_p continue to be the salinity variable that is stored in such data bases since S_p is closely related to the measured values of conductivity. This recommendation has the very important advantage that there is no change to the present practice and so there is less chance of transitional errors occurring in national and international data bases because of the adoption of Absolute Salinity in oceanography." (excerpt from McDougall et al., 2009A, Pages 10-11)

Consistent with the recommendations of WG127 that only Practical Salinity should be stored in databases, at this time Sea-Bird Electronics will continue to offer only Practical Salinity calculations in our computational software for analyzing data sets (Seasave and SBE Data Processing). However, for SBE Data Processing version 7.20a and later, we implemented the Absolute Salinity calculation as an option in SeaCalc II, a seawater calculator module in SBE Data Processing that computes a number of derived variables from one user-input data scan. This will enable scientists to become familiar with Absolute Salinity and the new equation of state, TEOS-10.

We refer to the following reference materials for the complete documentation on TEOS-10, which includes access to scripts implementing this new approach.

References

(McDougall et al., 2009A) McDougall, T.J., Feistel, R., Millero, F.J., Jackett, D.R., Wright, D.G., King, B.A., Marion, G.M., Chen, C-T.A., and Spitzer, P. 2009. *Calculation of the Thermophysical Properties of Seawater*, Global Ship-based Repeat Hydrography Manual, IOCCP Report No. 14, ICPO Publication Series no. 134.
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