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Interactive comment on “The effects of biogeochemical processes on oceanic conductivity/salinity/density relationships and the characterization of real seawater” by R. Pawlowicz et al.

Anonymous Referee #2

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I do not have sufficient expertise in seawater chemistry to be able to verify the details of the inorganic chemistry and electrochemical analysis. I can however comment on the significance of this work for the properties of seawater.

This paper explores a number of different meanings of seawater salinity, and the consequences of those definitions. As such it goes considerably further than the discussion and definition of salinity considered for the new Thermodynamic Equation for Seawater 2010 (TEOS-10). TEOS-10 recognises that because of geographical variations in the composition of seawater, there is not a unique algorithm that links a desired property,

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density, with the property most commonly measured in the field: conductivity. Accordingly, TEOS-10 is expressed in terms of an 'Absolute Salinity' which is intended to allow for such composition anomalies relative to a sample of known and defined 'Reference Composition'. The 'Absolute Salinity' of TEOS-10 is closely tied to density, and it is assumed that once this absolute salinity is known, then all the other derived thermodynamic properties of interest can be calculated from this absolute salinity. TEOS-10 was fitted to measurements that for the most part were made on samples of Standard SeaWater (SSW), and therefore close to Reference Composition. TEOS-10 therefore assumes that thermodynamic properties of any seawater sample, and their variation with temperature, pressure and salinity, are the same as those for a sample whose constituents appear in the same ratios as they appear in Reference Composition and matching density.

This paper considers two particular meanings of seawater salinity: One is calculated from the sum of the concentrations and molecular weights of individual constituents. The other is in effect the Absolute Salinity required as an argument of TEOS-10 to produce the sample density. For seawater of Reference Composition these two salinities are the same. For waters whose composition has been modified by biogeochemical processes these two salinities may not be the same. Furthermore, this paper shows that the haline contraction coefficient, the variation of density with salinity, may be significantly different when the two different meanings of salinity are employed. The delta-SA envisaged by TEOS-10 makes sense when the composition anomaly results in a small change in Absolute Salinity. This paper points out that when absolute salinity varies as a result of biogeochemical activity, then the change in composition (for example elements of the carbonate system) can be very different than if the same modification of salinity was achieved by the addition or removal of pure water. Therefore the haline contraction coefficient may no longer be the same as returned by TEOS-10, because the data on which TEOS-10 depends were pure-water dilutions of SSW.

As well as identifying the issues summarised above, the paper provides a detailed the-

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oretical basis for quantifying the differences between the definitions of Absolute Salinity. It considers variations of salinity additional to those considered in TEOS-10 and is therefore an important extension to that work. As a potential user of TEOS-10, what I missed was a clear summary of under what circumstances I might make important errors by using TEOS-10, and the SA_dens variable that TEOS-10 codes make available from lookup tables, and whether the different meanings of salinity impact on commonly used derived variables such as potential temperature, enthalpy and so on.

Interactive comment on Ocean Sci. Discuss., 7, 773, 2010.

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