Ocean Science
Discussions

Interactive comment on "Thermodynamic properties of standard seawater" *by* J. Safarov et al.

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1 General comments

The authors proposed a semi-empirical two-step approach to determine the thermodynamic properties of standard seawater. At first, the authors employed a state-of-the-art high pressure/high temperature vibrating tube densimeter to simultaneously measure pressure, density, and temperature of standard seawater, which were then fitted to a recently by Safarov (2003) proposed equation of state. Secondly, by means of classical relations from phenomenological thermodynamics, the authors derived a set of physical properties from the empirical equation of state, which are of high practical relevance (seawater demineralisation, geo-engineering, ocean/atmosphere modeling

etc.). An essential motivation of this work is the major extension of the temperature range and pressure range in comparison with previous works. The authors dangled to extent their analysis also for a wider salinity range in a forthcoming paper. As a non-professional but potential user, who is interested in application of the results, I found this paper very interesting, stimulating, and relevant with respect to the question of interest. Thus, it is nice, that is has been opened to the community. The paper is well-written and well-structured. The explanation of the experimental setup is traceable. I have checked all equations and found them being correct with exceptions. Below I will give some technical comments, which might be helpful to the authors, but at least not perturbing.

2 Technical comments

- Eqs. (4) & (5): insert full lower and upper summation indices (cf. Eq. (7));

- P. 696, line 13: remove colon after "where" (cf. also p. 699, line 25);

- P. 697, line 7: $\Delta\rho = \pm(0.1\,\text{to}\,0.3)$ kg m^{-3}, but write $\Delta\rho/\rho = \pm(0.011\,\text{to}\,0.03)$ % (several times);

- P. 698, Eqs. (6) & (7): It is unlucky to chose the symbols A, B, C to denote the temperature dependent coefficients, because A and B have already been used to denote the functions in Eqs. (4) & (5). The same is true for the coefficients in the polynomials. Maybe, one can use additional subscripts. Please check compatibility of summation indices in Eq. (7). B and C contain a temperature-independent term, A does not. Is this correct? Summation indices in Eq. (12) are wrong, if the summation indices in Eq. (7) are correct and vice versa.

- P. 700, Eqs. (14) & (15): The term $\alpha_\mathsf{T} = \gamma$ should be introduced as the isochoric thermal pressure coefficient by $\alpha_\mathsf{T} = (\partial p/\partial T)_\rho$. Ensure self-consistency

of annotation.

- P. 700, line 19: shown in Fig. 11;

- P. 700, Eq. (16): Measurement variable is density, but not volume, i. e., $p_{\text{int}} = T\left(\partial p / \partial T\right)_\rho - p$.

- P. 701, Eq. (17): With consideration of Eq. (8) the bulk modulus is defined as

$$K = -V \left(\frac{\partial p}{\partial V} \right)_T = \rho \left(\frac{\partial p}{\partial \rho} \right)_T = k_T^{-1} \ .$$

Thus, the values of both K and k_T should contain the same information (Figs. 7 & 13). What motivates the use of secant bulk modulus according to Eq. (17) instead of tangent bulk modulus? Secant bulk modulus requires definition of both (p, V) and (p_0, V_0). What is assumed for p_0 in Eq. (17) ?

- Whole paragraph from p. 701, line 19 to p. 703, line 6: Message is clear. But a data synopsis/survey is, perhaps, more catchy and self-evident in form of a **table** instead of text.

- P. 703, line 7-10: Either split or restructure this sentence (two verbs).

- For all Figures: Have the authors considered to present their results in form of isoline or isosurface plots, e.g., on the abscissa the temperature, on the ordinate the pressure, the value of the two-dimensional function as isolines or a surface? This would allow to show the details of the (nonlinear) polynom surface with fine temperature and pressure resolution. For example, in Fig. 2 the value of $\partial A / \partial p$ changes sign at temperatures somewhere in the middle of temperature range. (The many symbols are difficult to separate from each other for weak eyes such as my's ...).

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- Fig. 6: How can this figure be interpreted? Fixing pressure, then the scatter along the ordinate originates from the temperature range? Is there a systematic deviation or trend in dependence on temperature? Or is the error scatter irrelevant because of the absolute smallness of the error?

3 Summary

Please check Eqs. (7) & (12). Apart from that it is a nice paper!