

Notes on the function gsw_alpha(SA,CT,p)

This function, **gsw_alpha**(SA,CT,p), evaluates the thermal expansion coefficient with respect to Conservative Temperature from the 48-term rational function expression for density **gsw_rho**(SA,CT,p). This 48-term rational function expression for density is discussed in McDougall and Barker (2013) and in appendix A.30 and appendix K of the TEOS-10 Manual (IOC *et al.* (2010)). This thermal expansion coefficient α^Θ is defined as

$$\alpha^\Theta = - \frac{1}{\rho} \left. \frac{\partial \rho}{\partial \Theta} \right|_{S_A, p}, \quad (1)$$

and when evaluated from the 48-term computationally-efficient expression for density, the rms error compared with the same thermal expansion coefficient evaluated directly from the TEOS-10 Gibbs function is $0.069 \times 10^{-6} \text{ K}^{-1}$ in the “oceanographic funnel” (see Figures 1 and 2 below). This is to be compared with the rms error of the thermal expansion coefficient of the laboratory data to which the TEOS-10 Gibbs function was fitted of $0.73 \times 10^{-6} \text{ K}^{-1}$. Hence we may take the thermal expansion coefficient α^Θ evaluated from **gsw_alpha**(SA,CT,p) as essentially reflecting the full accuracy of TEOS-10. The exact thermal expansion coefficient α^Θ can be evaluated from **gsw_alpha_CT_exact**(SA,CT,p).

Further comments on the 48-term rational function expression for density may be found in the Help file of **gsw_rho**(SA,CT,p).

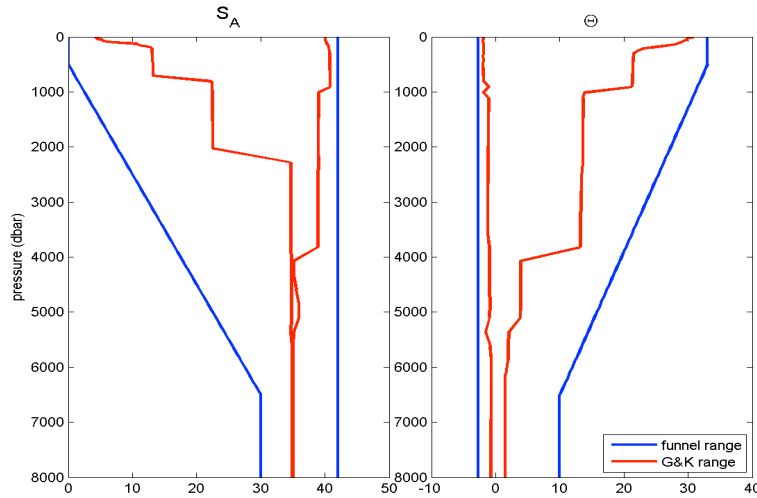


Figure 1. The ranges of Absolute Salinity and Conservative Temperature in the “oceanographic funnel” (the blue lines) in which the 48-term expression for density was fitted. The red lines shows the minimum and maximum values of Absolute Salinity and Conservative Temperature that occur in a hydrographic ocean atlas of the world ocean.

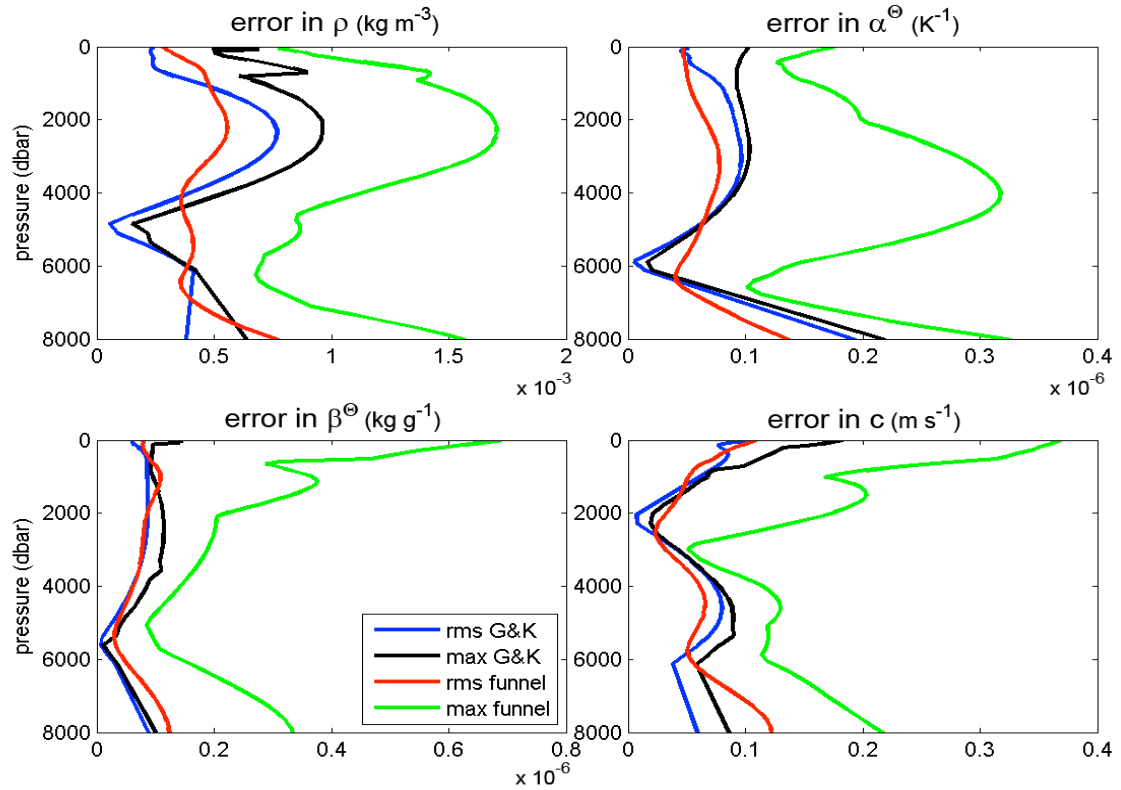


Figure 2. The errors in using the 48-term rational function expression for density, to evaluate density, the thermal expansion coefficient, the saline contraction coefficient and sound speed. The red and green lines are the r.m.s. and maximum errors for seawater in the “oceanographic funnel” (see Figure 1), while the blue and black lines are the r.m.s. and maximum errors for data in the world ocean.

References

- McDougall T. J. and P. M. Barker, 2013: A computationally efficient 48-term expression for the density of seawater in terms of Conservative Temperature, and related properties of seawater. To be submitted to *Journal of Atmospheric and Ocean Technology*.
- IOC, SCOR and IAPSO, 2010: *The international thermodynamic equation of seawater – 2010: Calculation and use of thermodynamic properties*. Intergovernmental Oceanographic Commission, Manuals and Guides No. 56, UNESCO (English), 196 pp. Available from <http://www.TEOS-10.org>