Notes on the function gsw_alpha(SA,CT,p) (which is identical to gsw_alpha_CT(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) (which is identical to **gsw_rho_CT**(SA,CT,p)). This 48-term rational function expression for density is discussed in McDougall *et al*. (2011) 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

$$\alpha^\Theta = -\frac{1}{\rho}\frac{\partial \rho}{\partial \Theta}\bigg|_{S_A,p}, \qquad (1)$$

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 $0.069 x10^{-6}\,\mathrm{K}^{-1}$ 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 $0.73 x10^{-6}\,\mathrm{K}^{-1}$. Hence we may take the thermal expansion coefficient α^Θ evaluated form **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).

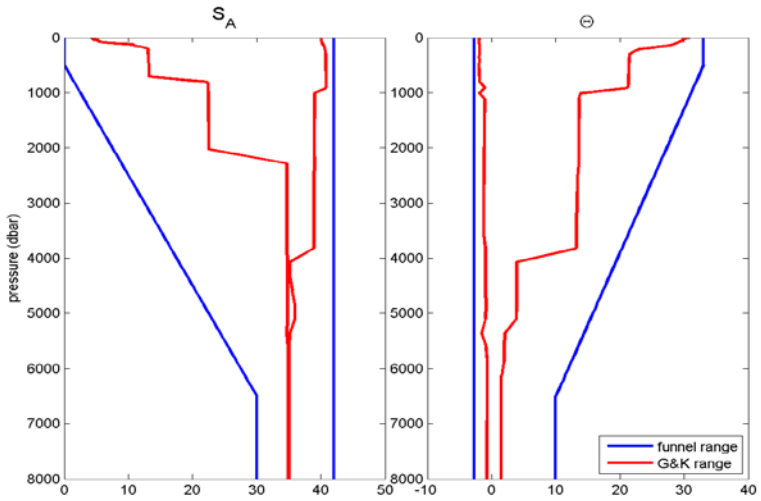

Figure 1. The ranges of Absolute Salinity and Conservative Temperature in the "oceanographic funnel" (the blue lines) in which the 48-term expression for density was fitted. The red lines shows the minimum and maximum values of Absolute Salinity and Conservative Temperature that occur in a hydrographic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

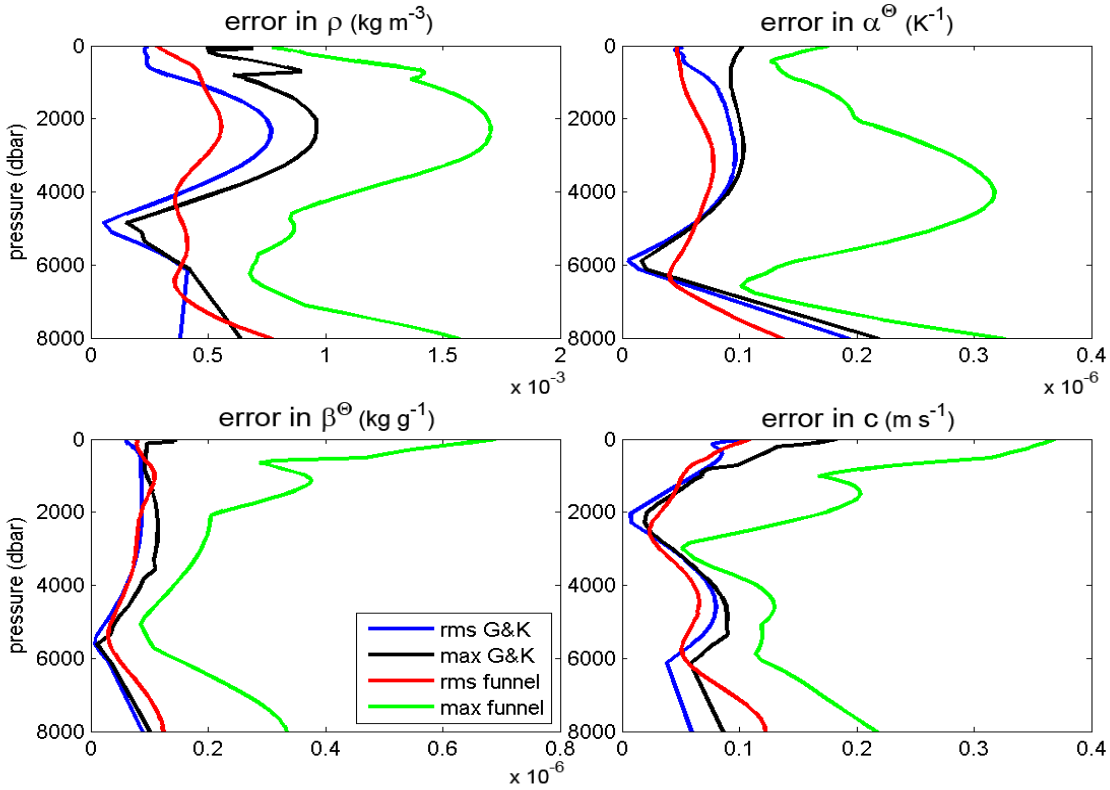

Figure 2. The errors in using the 48-term rational function expression for density, to evaluate density, the thermal expansion coefficient, the saline contraction coefficient and sound speed. The red and green lines are the r.m.s. and maximum errors for seawater in the "oceanographic funnel" (see Figure 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., P. M. Barker, R. Feistel and D. R. Jackett, 2011: A computationally efficient 48-term expression for the density of seawater in terms of Conservative Temperature, and related properties of seawater. submitted to *Ocean Science Discussions*.

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