Notes on the function gsw_sigma1(SA,CT) (which is identical to gsw_sigma1_CT(SA,CT))

Potential density anomaly is defined by Eqn. (3.6.1) of IOC *et al*. (2010), namely

$$\begin{aligned} \sigma^{\Theta}(S_A, t, p, p_r) &= \rho^{\Theta}(S_A, t, p, p_r) - 1000 \text{ kg m}^{-3} \\ &= \hat{\rho}(S_A, \Theta, p_r) - 1000 \text{ kg m}^{-3}. \end{aligned} \tag{1}$$

This function, **gsw_sigma1**(SA,CT), (which is identical to **gsw_sigma1_CT**(SA,CT)) evaluates the potential density anomaly of seawater as a function of Absolute Salinity and Conservative Temperature, and with respect to a reference pressure p_r of 1000 dbar using the 48-term expression, $\hat{\rho}(S_A, \Theta, p)$ of the GSW function **gsw_rho**(SA,CT,p). This 48-term rational function expression for density and specific volume is discussed in McDougall *et al*. (2011) and in appendix A.30 and appendix K of the TEOS-10 Manual (IOC *et al*. (2010)).

References

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

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*.

Here follows section 3.6 of the TEOS-10 manual (IOC *et al*. (2010)).

3.6 Potential density anomaly

Potential density anomaly, σ^{θ} or σ^{Θ}, is simply potential density minus 1000 kg m^{-3},

$$\begin{aligned} \sigma^{\theta}(S_A, t, p, p_r) = \sigma^{\Theta}(S_A, t, p, p_r) &= \rho^{\theta}(S_A, t, p, p_r) - 1000 \text{ kg m}^{-3} \\ &= \rho^{\Theta}(S_A, t, p, p_r) - 1000 \text{ kg m}^{-3} \\ &= g_P^{-1}(S_A, \theta[S_A, t, p, p_r], p_r) - 1000 \text{ kg m}^{-3}. \end{aligned} \tag{3.6.1}$$

Note that it is equally correct to label potential density anomaly as σ^{θ} or σ^{Θ} because both θ and Θ are constant during the isentropic and isohaline pressure change from p to p_r.