Notes on the function gsw_sigma1(SA,CT)

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

$$\begin{aligned}\sigma^{\Theta}\left(S_{\mathrm{A}},t,p,p_{\mathrm{r}}\right) &= \rho^{\Theta}\left(S_{\mathrm{A}},t,p,p_{\mathrm{r}}\right)-1000\ \mathrm{kg\ m^{-3}} \\ &= \hat{\rho}\left(S_{\mathrm{A}},\Theta,p_{\mathrm{r}}\right)-1000\ \mathrm{kg\ m^{-3}}.\end{aligned} \tag{1}$$

This function, **gsw_sigma1**(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 75-term expression, $\hat{v}(S_{\mathrm{A}},\Theta,p)$ of the GSW function **gsw_specvol**(SA,CT,p). This 75-term polynomial expression for specific volume is discussed in Roquert et al. (2015) 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

Roquet, F., G. Madec, T. J. McDougall and P. M. Barker, 2015: Accurate polynomial expressions for the density and specific volume of seawater using the TEOS-10 standard. Ocean Modelling, 90, pp. 29-43. http://dx.doi.org/10.1016/j.ocemod.2015.04.002

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},

$$\begin{aligned}\sigma^{\theta}\left(S_{\mathrm{A}},t,p,p_{\mathrm{r}}\right) = \sigma^{\Theta}\left(S_{\mathrm{A}},t,p,p_{\mathrm{r}}\right) &= \rho^{\theta}\left(S_{\mathrm{A}},t,p,p_{\mathrm{r}}\right)-1000\ \mathrm{kg\ m^{-3}} \\ &= \rho^{\Theta}\left(S_{\mathrm{A}},t,p,p_{\mathrm{r}}\right)-1000\ \mathrm{kg\ m^{-3}} \\ &= g_{P}^{-1}\left(S_{\mathrm{A}},\theta\left[S_{\mathrm{A}},t,p,p_{\mathrm{r}}\right],p_{\mathrm{r}}\right)-1000\ \mathrm{kg\ m^{-3}}.\end{aligned} \tag{3.6.1}$$

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}.