Notes on the function
gsw_sigma1(SA,CT)

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

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

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 48-term expression, $\hat{\rho}\left(S_{\mathrm{A}},\Theta,p\right)$ of the GSW function **gsw_rho**(SA,CT,p). This 48-term rational function expression for density and specific volume is discussed in McDougall and Barker (2013) 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., 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 ans Oceanic Technology*.

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},

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

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}.