Notes on the function gsw_sigma3_CT_exact(SA,CT)

Potential density anomaly σ^{Θ} is defined by Eqn. (3.6.1) of IOC *et al*. (2010), namely

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

The present function, **gsw_sigma3_CT_exact**(SA,CT), calculates potential density with a reference pressure of $3000\ \mathrm{dbar}$, and uses the full TEOS-10 Gibbs function $g\left(S_{\mathrm{A}},t,p\right)$ of IOC *et al*. (2010), being the sum of the IAPWS-09 and IAPWS-08 Gibbs functions.

This function is simply two calls to other GSW functions, as follows,

```
pr3000 = 3000*ones(size(SA));
t = gsw_t_from_CT(SA,CT,pr3000);
sigma3_CT_exact = gsw_rho_t_exact(SA,t,pr3000) - 1000;
```

References

IAPWS, 2008: Release on the IAPWS Formulation 2008 for the Thermodynamic Properties of Seawater. The International Association for the Properties of Water and Steam. Berlin, Germany, September 2008, available from www.iapws.org. This Release is referred to in the text as **IAPWS-08**.

IAPWS, 2009: Supplementary Release on a Computationally Efficient Thermodynamic Formulation for Liquid Water for Oceanographic Use. The International Association for the Properties of Water and Steam. Doorwerth, The Netherlands, September 2009, available from http://www.iapws.org. This Release is referred to in the text as **IAPWS-09**.

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

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},

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

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}.