Notes on the function gsw_isopycnal_vs_ntp_CT_ratio(SA,CT,p)

This function \texttt{gsw\_isopycnal\_vs\_ntp\_CT\_ratio}(SA,CT,p) evaluates the “isopycnal temperature gradient ratio” defined by (from section 3.17 of the TEOS-10 Manual, IOC et al. (2010))

\[
G^\theta = \frac{[R_p-1]}{[R_p/r-1]}.
\]  

(3.17.4)

This is the ratio of the (parallel) gradient of Conservative Temperature in a potential density surface, \(\nabla_{\sigma}\Theta\), to that in a neutral tangent plane, \(\nabla_{n}\Theta\), since, from Eqn. (3.17.3) of the TEOS-10 Manual,

\[
\nabla_{\sigma}\Theta = \frac{r[R_p-1]}{R_p-r}\nabla_{n}\Theta = G^\theta\nabla_{n}\Theta.
\]  

(3.17.3)

This function, \texttt{gsw\_isopycnal\_vs\_ntp\_CT\_ratio}(SA,CT,p), uses the 75-term polynomial function expression for specific volume \texttt{gsw\_specvol}(SA,CT,p). This 75-term polynomial expression for specific volume is discussed in Roquet et al. (2015) and in appendix A.30 and appendix K of the TEOS-10 Manual (IOC et al. (2010)). For dynamical oceanography we may take the 75-term polynomial expression for specific volume as essentially reflecting the full accuracy of TEOS-10.

References


Here follows section 3.17 of the TEOS-10 Manual (IOC et al. (2010)).

3.17 Property gradients along potential density surfaces

The two-dimensional gradient of a scalar \(\phi\) along a potential density surface \(\nabla_{\phi}\phi\) is related to the corresponding gradient in the neutral tangent plane \(\nabla_{\phi}\phi\) by

\[
\nabla_{\phi}\phi = \nabla_{n}\phi + \frac{\phi}{\Theta} \frac{R_p[r-1]}{R_p-r} \nabla_{n}\Theta
\]  

(3.17.1)

(from McDougall (1987a)), where \(r\) is the ratio of the slope on the \(S_\lambda-\Theta\) diagram of an isoline of potential density with reference pressure \(p\), to the slope of a potential density surface with reference pressure \(p\), and is defined by

\[
r = \frac{\alpha^{\phi}(S_\lambda,\Theta,p)/\beta^{\phi}(S_\lambda,\Theta,p)}{\alpha^{\phi}(S_\lambda,\Theta,p_t)/\beta^{\phi}(S_\lambda,\Theta,p_t)}.
\]  

(3.17.2)
Substituting $\varphi = \Theta$ into (3.17.1) gives the following relation between the (parallel) isopycnal and epineutral gradients of $\Theta$

$$\nabla_\sigma \Theta = \frac{r \left[ R_{\rho} - 1 \right]}{R_{\rho} - r} \nabla_n \Theta = G^\Theta \nabla_n \Theta \quad (3.17.3)$$

where the “isopycnal temperature gradient ratio”

$$G^\Theta = \frac{\left[ R_{\rho} - 1 \right]}{R_{\rho} / r - 1} \quad (3.17.4)$$

has been defined as a shorthand expression for future use. This ratio $G^\Theta$ is available in the GSW Toolbox from the algorithm gsw_isopycnal_vs_ntp_CT_ratio, while the ratio $r$ of Eqn. (3.17.2) is available there as gsw_isopycnal_slope_ratio. Substituting $\varphi = S_\lambda$ into Eqn. (3.17.1) gives the following relation between the (parallel) isopycnal and epineutral gradients of $S_\lambda$

$$\nabla_\sigma S_\lambda = \frac{\left[ R_{\rho} - 1 \right]}{R_{\rho} - r} \nabla_n S_\lambda = \frac{G^\Theta}{r} \nabla_n S_\lambda. \quad (3.17.5)$$