Notes on the GSW function gsw_temps_maxdensity

This function, gsw_temps_maxdensity calculates (using a modified Newton-Raphson iteration procedure) the temperature(s) at which seawater density is a maximum at given values of Absolute Salinity (g kg^{-1}) and pressure (dbar). It does this by finding the in situ temperature at which $g_{PT} = v_T$ is zero. The function returns this value of in situ temperature t as well as the potential temperature θ (referenced to $p_r = 0$ dbar) and the Conservative Temperature Θ at this point of maximum density.

3.42 Temperature of maximum density

At about 4 °C and atmospheric pressure, pure water has a density maximum below which the thermal expansion coefficient and the adiabatic lapse rate change their signs (Röntgen (1892), McDougall and Feistel (2003)). At salinities higher than 23.8 g kg^{-1} the temperature of maximum density t_{MD} is below the freezing point t_f (Table 3.42.1). The seasonal and spatial interplay between density maximum and freezing point is highly important for the stratification stability and the seasonal deep convection for brackish estuaries with permanent vertical and lateral salinity gradients such as the Baltic Sea (Feistel *et al.* (2008b), Leppäranta and Myrberg (2009), Reissmann *et al.* (2009)).

The temperature of maximum density t_{MD} is computed from the condition of vanishing thermal expansion coefficient, that is, from the solution of the implicit equation for $t_{MD}(S_A, p)$,

$$g_{TP}\left(S_A, t_{MD}, p\right) = 0. \qquad (3.42.1)$$

The temperature of maximum density is available in the GSW computer software library as function gsw_temps_maxdensity. This function also returns the potential temperature and the Conservative Temperature at this maximum density point. Selected TEOS-10 values computed from this equation are given in Table 3.42.1.

Table 3.42.1: Freezing temperature t_f and temperature of maximum density t_{MD} for air-free brackish seawater with absolute salinities S_A between 0 and 25 g kg^{-1}, computed at the surface pressure from TEOS-10. Values of t_{MD} in parentheses are less than the freezing temperature.

S_A g kg^{-1}	t_f °C	t_{MD} °C	S_A g kg^{-1}	t_f °C	t_{MD} °C	S_A g kg^{-1}	t_f °C	t_{MD} °C
0	+0.003	3.978	8.5	–0.456	2.128	17	–0.912	0.250
0.5	–0.026	3.868	9	–0.483	2.019	17.5	–0.939	0.139
1	–0.054	3.758	9.5	–0.509	1.909	18	–0.966	0.027
1.5	–0.081	3.649	10	–0.536	1.800	18.5	–0.994	–0.085
2	–0.108	3.541	10.5	–0.563	1.690	19	–1.021	–0.196
2.5	–0.135	3.432	11	–0.590	1.580	19.5	–1.048	–0.308
3	–0.162	3.324	11.5	–0.616	1.470	20	–1.075	–0.420
3.5	–0.189	3.215	12	–0.643	1.360	20.5	–1.102	–0.532
4	–0.216	3.107	12.5	–0.670	1.249	21	–1.130	–0.644
4.5	–0.243	2.999	13	–0.697	1.139	21.5	–1.157	–0.756
5	–0.269	2.890	13.5	–0.724	1.028	22	–1.184	–0.868
5.5	–0.296	2.782	14	–0.750	0.917	22.5	–1.212	–0.980
6	–0.323	2.673	14.5	–0.777	0.807	23	–1.239	–1.092
6.5	–0.349	2.564	15	–0.804	0.696	23.5	–1.267	–1.204
7	–0.376	2.456	15.5	–0.831	0.584	24	–1.294	(–1.316)
7.5	–0.403	2.347	16	–0.858	0.473	24.5	–1.322	(–1.428)
8	–0.429	2.238	16.5	–0.885	0.362	25	–1.349	(–1.540)