EAS 4305/6305 Physics and Chemistry of the Oceans
Homework #2: Due September 6th

Equation of state, T-S diagram and ocean stratification

The goal of this homework is to calculate potential density (σ_θ) from HOT and to develop a T-S diagram.

1. Download two MATLAB functions: *sweos.m* for calculating the density of seawater at the surface pressure available from https://github.com/eas2655-taka/oceanography

2. Make a T-S diagram. X-axis is salinity ($33.5<S<37.5$) and Y-axis is potential temperature ($-2<\theta<30$). Using the above MATLAB functions (*sweos.m*), calculate the values of potential density (σ_θ) as a function of θ and S and plot it as a contour diagram. (See tutorial examples of contour plotting at: http://www.mathworks.com/help/matlab/ref/contour.html. *Make sure that your plots have X- and Y-axes properly labeled with units.*

3. Then, on top of the potential density (σ_θ) contour, make scatter plot(s) of the **winter-time (Dec-Jan-Feb) HOT (θ, S) data.**

4. In the T-S diagram(s), identify the major water masses in the Pacific Ocean with a characteristic values of (θ, S) properties. What are the values of θ, S, and σ_θ for the following water masses?

    a. North Pacific Subtropical Mode Water
    b. North Pacific Intermediate Water
    c. Pacific Deep Water

5. Using MATLAB, plot histograms of potential temperature and salinity. (Use "hist" function in MATLAB. See tutorial examples of histogram: http://www.mathworks.com/help/matlab/ref/hist.html?searchHighlight=hist In this case the histogram plots the number of measurements in y axis and temperature in x axis. What is the most frequently measured values of **(θ, S)** at HOT?

6. Review the results from HW1 and identify the approximate depths of the three water masses in (4), and confirm that potential density increases with depths – so the water column is stably stratified.

Appendix: Thermodynamic Equation Of State (UNESCO, 1981)

The equation of state at the surface pressure has the following form:

$$\rho(0,T) = \sum_n a_n T^n$$

$$\rho(S,T) = \rho(0,T) + S\sum_n b_n T^n + S^{\frac{3}{2}}\sum_n c_n T^n + d_0 S^2$$

where S is salinity in units of (psu), and T is temperature in units of Celsius degree. This is a commonly used formula before TEOS 2010. Constants for the polynomial are listed in the Table below.

Table 1. The coefficients for the density of seawater referenced at the surface pressure (0dbar)

Variable	n=1	n=2	n=3	n=4	n=5	n=6
a	999.843	0.0679395	-0.00909529	0.000100169	-1.12008E-06	6.53633E-09
b	0.824493	-0.0040899	0.000076438	-8.2467E-07	5.3875E-09	0
c	-0.0057247	0.00010227	-1.6546E-06	0	0	0
d	0.00048314	0	0	0	0	0