

Problem set 3, 12.808

Three problems are asked: all requiring use of the WHP/SAC global hydrographic atlas. The atlas provides a climatology with 1 degree of latitude/longitude resolution as provided as part of the class material on the website. The climatology was produced using the WOCE Hydrographic Programme data as a guide to quality control all previously available data for the world ocean. Data are optimally mapped on density surfaces. Further details can be found in the following report:

Gouretski, V. V., and K. P. Koltermann, WOCE Global Hydrographic Climatology, a technical report. Berichte des BSH, Nr. 35/2004, 52pp, 2004, <www.bsh.de>.

Problem A: T. Joyce

In our Ocean Circulation reference, according to the class notes, the global figure of dynamic height relative to 1500 dbar shown [fig 3.21, p. 62] is incorrect. You are requested to

1. plot and contour the dynamic height [geopotential anomaly/10] over the world ocean using the atlas. What regions have the largest values and which the smallest?
2. Discuss the differences between the northern Pacific & Atlantic oceans in terms of dynamic sea level differences.

[hint: use the program atlas.m on the website as a guide for this problem]

Problem B: T. Joyce

In the tropical Pacific, there is a slight asymmetry between the north and south Pacific in terms of temperature and zonal velocity [fig. 5.5, p. 149 in Ocean Circulation]. Use the Atlas to

1. contour a salinity, temperature and neutral density section between 10 N/S in the central Pacific; discuss the salinity contrast between the upper waters of the North & South Pacific.
2. Select a density surface that goes through the core of the equatorial undercurrent and plot a horizontal, plan view map of the tropical Pacific & Indian Oceans with salinity & pressure variations on this density surface
3. Based on your results, discuss whether North or South Pacific Water enters the Indian Ocean between Indonesia & Australia.

[hint: for making sections and for interpolation onto neutral density surfaces, look at the examples in the script “atlas.m” on the website]

Problem C: R. Ferrari

1. Take the whole Atlas data set and compute the potential temperature Theta. You will need the MATLAB seawater libraries for this calculation (you must use the function `sw_ptmp`). You will also need the seawater libraries to run the routine `TSvolumetric` (attached to this email).
2. Use the routine `TSvolumetric` (attached to this email) to compute the Theta-S volumetric diagram for the global oceans. The parameters you must pass to the routine are: potential temperature, salinity, neutral density, longitude, latitude, pressure, range of neutral density surfaces, potential temperature bins, salinity bins. The parameter `gammarange` is a 2 element vector with the minimum and maximum neutral density surface you want to consider in your calculation, say `gammarange=[27.8,28.2]`. The Theta-S volumetric diagram is calculated on a Theta-S grid given by the 1D vectors `thetarange` and `salrange`, for example `thetarange=[-1:0.1:4]` and `salrange=[34.4:.01:35]`. The routine returns the values at which the Theta-S diagram has been evaluated (T and S) and the ocean volume occupied by each Theta-S point (TSvol). The routine makes the approximation that 1 decibar = 1 meter, and takes into account that a 1x1 degree area changes with latitude.
3. Plot the Theta-S volumetric diagram for the Theta-S ranges given in Fig. 6-46a , p. 254 of Ocean Circulation. Can you identify the neutral density ranges that identify the Antarctic Bottom Water and the Common Deep Water shown in Fig. 6-47? Draw the Theta-S volumetric diagram for these two water masses and estimate the fraction of ocean volume that these two water masses occupy.