

**2.011 HW #3**  
**Spring 2006**  
**Due Thursday 3/9/06**

**Problem 1:** If the thermal energy from solar radiation is largely absorbed by the surface layers how can it be carried deeper? Discuss possible physical mechanisms for heat transport in the ocean.

**Problem 2:** Seawater versus freshwater

- a) Explain why colder water can overlie water at 4° C in a freshwater lake in a gravitationally stable situation. Could such a situation develop in the ocean?
- b) Explain why the temperature profiles in a freshwater lake will not show temperatures decreasing with depth to values less than 4° C.

**Problem 3:** Practical Salinity is related to the conductivity ratio  $K_{15}$  (ratio of conductivity of a seawater sample to conductivity of standard seawater [KCl] solution @ 15°C and 1atm) and determined by the following equation

$$S = 0.0080 - 0.1692 K_{15}^{1/2} + 25.3851 K_{15} + 14.0941 K_{15}^{3/2} - 7.0261 K_{15}^2 + 2.7081 K_{15}^{5/2}$$

When  $K_{15} = 1$  what is  $S$ ?

**Problem 4:** Potential Temperature and sigma-t

- a) Explain whether you expect the potential temperature of (i) air at a height of 5km and (ii) seawater at a depth of 5km to be greater or less than their *in situ* temperatures.
- b) Using the figure below, what are the values of sigma-t ( $\sigma_t$ ) at (i)  $T = 2^\circ\text{C}$  and  $S = 34.5\text{‰}$  and (ii)  $T = 15^\circ\text{C}$  and  $S = 35.6\text{‰}$ ?
- c) What do those values of sigma-t ( $\sigma_t$ ) mean in terms of (i) the specific gravity of the water at atmospheric pressure and (ii) the density at atmospheric pressure?
- d) By looking at the figure, keeping in mind the range of  $T$  and  $S$  usually found in the oceans, do you think that temperature or salinity would have a greater effect on seawater density?

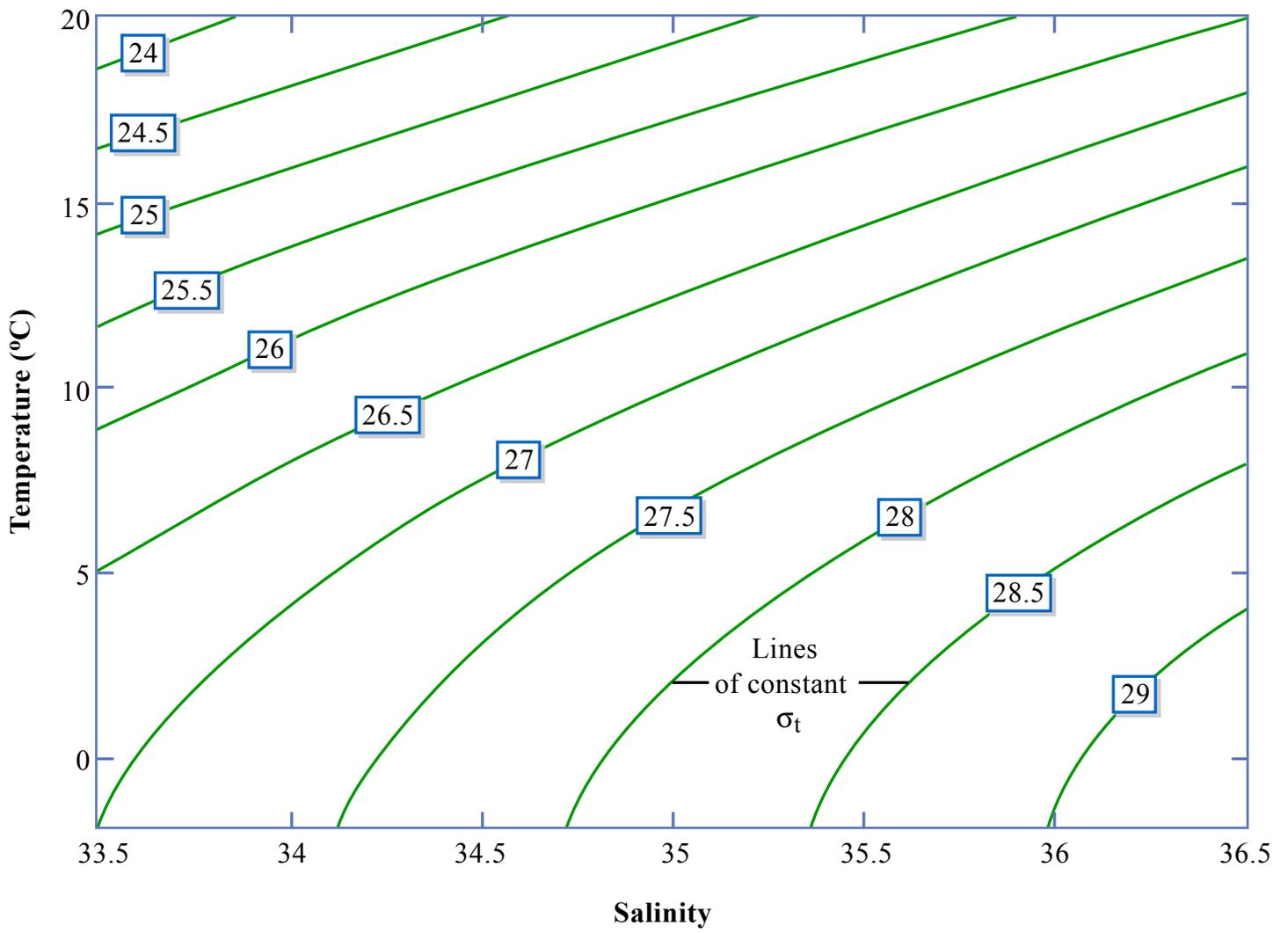


Figure by MIT OCW.

**Problem 5:** The figures below are vertical sections showing the mean distribution of temperature and salinity in the western Atlantic Ocean. Contour lines show the ocean temperature in degrees Celsius in the top figure and salinity in parts per thousand in the lower figure.

a) Discuss how the range of temperature and salinity varies with depth. How do the surface waters compare to the deeper waters.

Note that for the temperature contour plot, the dashed isotherms step in  $1^{\circ}$  C intervals, whereas the solid contour lines step in  $5^{\circ}$  C intervals, and for the salinity contours, the dashed haloclines vary in 0.1 and 0.2 ‰ and the solid haloclines vary in 0.5 ‰ intervals.

b) Two vertical temperature profiles are taken at stations A and B. Determine which profile plotted below the contour map corresponds to profile A and B.

c) Which salinity-depth profile corresponds with the vertical lines (A, B) in the contour plot of salinity?

d) How do the depth ranges of the haloclines compare with those of the thermoclines shown in the figure above?

e) Which of the two halocline plots shows the greater rate of decrease of salinity with depth?

[FIGURES ON NEXT PAGE]

Figures removed for copyright reasons.

**Problem 6:** Using the following table and plots:

- a) Match each plot with one of the following descriptions:
- i. Cool water flows over the sill (Marianas ridge), descending slightly across the Mindanao Trench but remaining in the middle depths to leave the warmer bottom water undisturbed.
  - ii. Cool water passes over the sill and flows down the slope of to the bottom of the trench.
- b) Assuming that salinity is not exerting any significant control over density, which of the two situations, (i) or (ii), described above in (a) is likely to exist in reality?

Depth (m)	Salinity	Temperature		Density	
		In situ (°C)	Potential (°C)	$\sigma_t$	Potential ( $\sigma_\theta$ )
1455	34.58	3.20	3.09	27.55	27.56
2470	34.64	1.82	1.65	27.72	27.73
3470	34.67	1.59	1.31	27.76	27.78
4450	34.67	1.65	1.25	27.76	27.78
6450	34.67	1.93	1.25	27.74	27.79
8450	34.69	2.23	1.22	27.72	27.79
10035	34.67	2.48	1.16	27.69	27.79

Comparison of in situ and potential temperatures in the Mindanao Trench off the Philippine Islands.

Figure by MIT OCW.

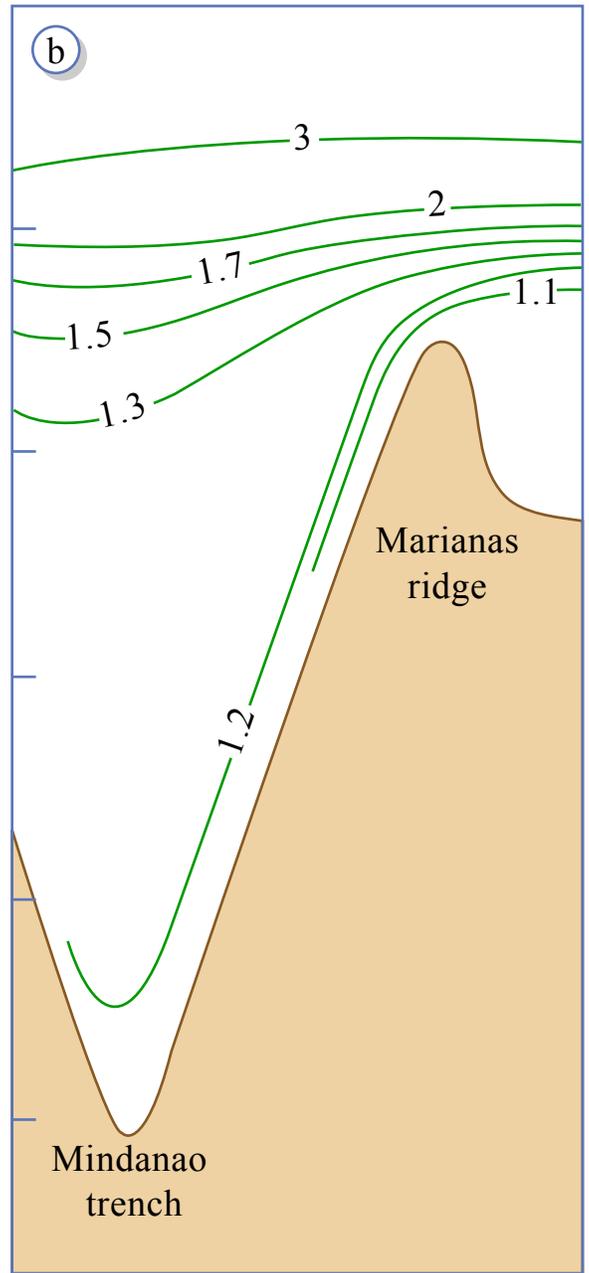
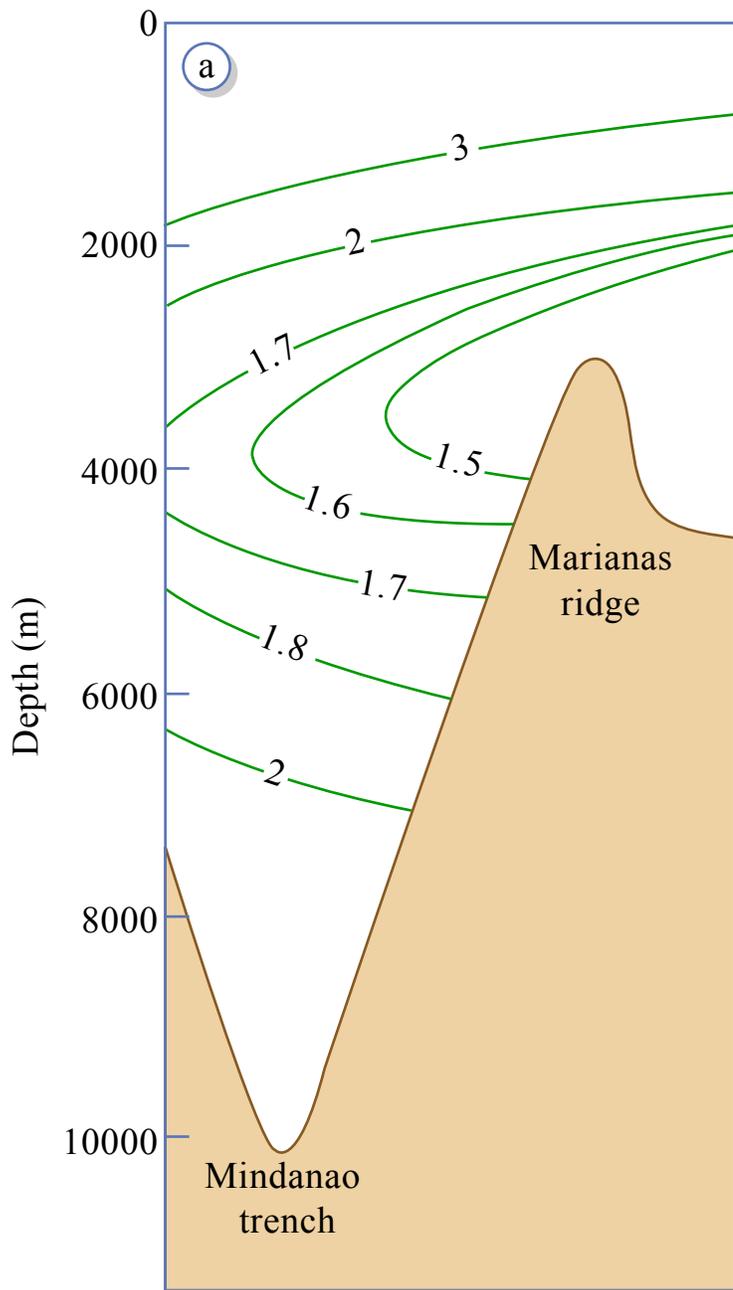


Figure by MIT OCW.

**Problem 7:** Light propagation in the ocean

- a) At what velocity does light propagate in the ocean? Compare this to the speed of sound in the ocean.
- b) Describe briefly why some light is reflected at the ocean surface. How much is this on average (% of light reflected)?
- c) Is there a correlation between light attenuation and ocean temperature? If so explain.
- d) What effects what “color” the ocean looks like on a clear day from space? Consider both ocean properties and other ‘stuff’ in the water.