Discussion question for Deep and Intermediate Water Circulation, Ocean 423, April 9, 2009

I have brought to class oceanographic atlases of three different ocean basins. I will divide you into groups of 3/4 to answer the following questions about your ocean. After you have done that, you will show members of the other groups what you have learned. You will be paying attention to the water masses that have distinct signature in salinity as well as the strongest currents in each basin. You will be looking at the structure of the thermocline as well as the intermediate and deep waters of each basin. You should concentrate on the temperature, salinity, and possibly density sections.

Some water masses that you should try to identify:
Antarctic Intermediate Water (AAIW)
Antarctic Bottom Water (AABW)
North Atlantic Deep Water (NADW)
North Pacific Intermediate Water (NPIW)
Mediterranean Water (MW)

For the North Atlantic

First, examine the Western Atlantic section in the Geosecs atlas and answer the following questions

1. What is the shape of the thermocline as a function of latitude? Sketch it.

2. There are three distinct water masses below the thermocline in the section AAIW, AABW and NADW. Identify them in the section.

3. Look at the Eastern Atlantic section. Once again, identify the three water masses listed in (2) above. Are the property maxima/minima stronger or weaker than in the west?

4. Now take a look at the Erica Dan Atlas. Look at the maps of salinity on potential temperature surfaces. On the 1C surface, where is the water coming from?

6. Move up to the 1.4C surface. What path does the water from the south take water? What about the water from the North?

7. Two new sources are seen at the 2.4C surface. What is the water mass that is occurring around 30-40N coming from? Can you identify it?

8. Now look at the Fuglister Atlas. In the 32 and 36N sections of temperature, find the Gulf Stream.

9. One of the water masses identified in (7) can be identified in the 36N section. Can you identify it?

For the North Pacific

1. Look at the 47N section. Find a local minimum in temperature. How is this minimum maintained without the water column overturning?

2. Look at the 30N section. How does the depth of the thermocline change across the basin? Sketch it.

3. Look at the 30N and 24N sections. Find the Kuroshio in them.

4. Find the NPIW in the 24N section. What characterizes this water mass?

5. Look at the 32S section. Where is the coldest water? What role does bathymetry play in its circulation?

6. Look at the 165E section. Find the NPIW and the Kuroshio Extension.

7. Look for NPIW and AAIW in the 179E and 165W sections. What is the structure the thermocline as a function of latitude?

8. Look at the tropical thermocline and find the equatorial undercurrent.

9. Look at the maps of the depth of neutral density of 26. What is the shape of the subtropical thermocline. Find the NPIW in the map of salinity on the 26 neutral density surface.

10. In the map of Neutral density of 27.3 find the AAIW.

11. Look at the 28.01 Neutral Density surface. Find the source of the deepest water.

For the Southern ocean

1. Look at the Drake passage S1 section. Find the Antarctic Circumpolar Current. How do you identify it? How deep does is penetrate?

2. Look at the meridional sections, A23, S2 and identify the NADW, AAIW and AABW.

3. As you look at sections as you go east around the coast of Antartica, how does the distribution of the three water masses change? What happens to the extent and properties of the NADW? In particular, look at I8, I9, and P11, P15, P17.

4. Now examine how the AAIW changes around the Antarctic content.

5. Do the same for AABW as in (3).

4. Now examine the maps on the 27.4 isopycnal surface. Look at the depth of the surface, and the salinity. Examine the spatial distribution of the low salinity water (AAIW). Compare what you see with what you found in (4) above.

5. Examine the maps on the 28.05 surface and examine the distribution of NADW.

6. Using what you learned about the evolution of NADW, AABW, and AAIW, described
a) Where does the AABW originate? How is it related to NADW?
b) Where does AAIW originate?
b) What happens to NADW when it reaches the Southern Ocean?
c) How do water masses evolve as they move away from their source regions?