Journal 23
Wednesday

1. 012200Z February 05
2. Position: Lat: 54-00.3S, LONG: 150-00.0W
3. Course: On Station
4. Speed: 10.2 kts
5. Distance: 92.6 NM
6. Steaming Time: 09H 06M
7. Station Time: 14H 54M
8. Fuel: 3,137 gals
9. Sky: St 8
10. Wind: 280-T, 25 Kts
11. Sea: 280-T, 5-7 Ft
12. Swell: 270-T, 8-14 Ft
13. Barometer: 1007.2 mb
14. Temperature: Air: 9.5 C, Sea: 5.0 C
15. Equipment Status: Normal
16. Comments: none

MASTER, R/V *ROGER REVELLE*

We are still heading south. The weather is a little calmer and we are making very good time. It looks as if we may make it all the way to 67°S or further before we have to turn and head for New Zealand.

Dr. Swift has done a nice description of some of the data that was collected on the first cruise covering this line and the opposite one in the Atlantic. We are now repeating that cruise to compare data and look at changes. He is including some figures showing differences in many of the parameters they are looking at. I asked him to include the data from the Atlantic because my students have done a density profile of the Atlantic that looks similar to these diagrams. We were looking at the water masses using density using temp/salinity. I want my students to compare the water mass diagram in the Atlantic with the Pacific. There are big differences and I want them to think about some reasons for these differences. We will discuss the possible reasons in class.

Dr. Swift compiled this for me in a small paper and I am going to try to put it in several journals with the figures. Later, I will put it all together on the website and have some class activities to go with the information and figures. This is Part 1:

Atlantic/Pacific Hydrography Comparison - A First Lesson

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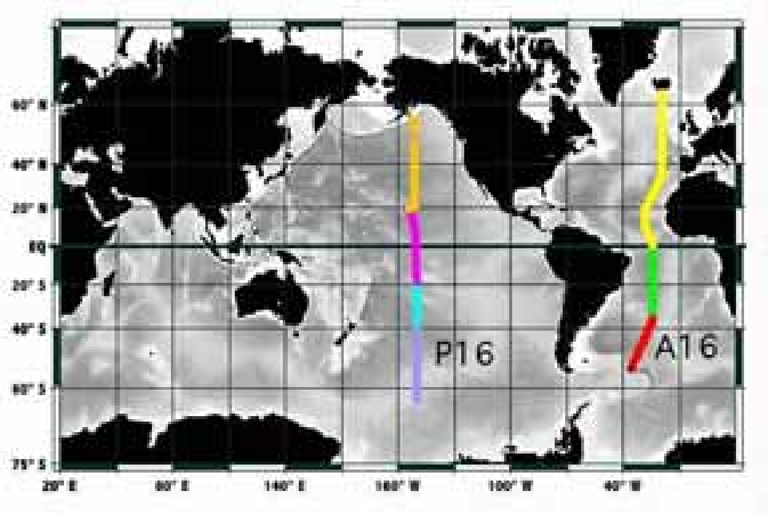
26 January 2005



About the Sections

These are the "A16" and "P16" south-north hydrographic transects from the 1980s and 1990s. The "A" and "P" stand for "Atlantic" and "Pacific", respectively (there is no special meaning to the "16", and the fact that both are 16s is a coincidence). The sections were part of the World Ocean Circulation Experiment (WOCE), which was the largest and most expensive oceanography program ever. The word "hydrography" most often deals with maritime charting of depths, currents, and water conditions, for example, along coastlines. In modern oceanography, the word "hydrography" has been expanded and specialized to refer more to measurements of the principal physical and chemical characteristics of seawater, such as temperature, salinity, dissolved gases, and other dissolved substances. The hydrographic measurements represented by these transects were but one part of WOCE. There were many other WOCE measurements, such as from moored instruments, expendable profilers, satellite observations, and meteorology.

Both the A16 and P16 transects are shown with south on the left and north on the right.

The Atlantic A16 transect begins in the Weddell Sea off Antarctica and proceeds north along approximately 25°W through the Atlantic Ocean, including several crossings of the Atlantic Mid-Ocean Ridge, ending at Iceland in the north.

The Pacific P16 transect begins just outside the Ross Sea and traverses the Southeast, East Central, and Northeast Pacific along 150°W, ending at Kodiak Island in the north.

For various oceanographic reasons the ideal transects for comparison of the Atlantic and Pacific Oceans would probably traverse the western basins of each ocean, but I used the A16 and P16 transects from the 1980s and 1990s because: (1) there are no ideal transects, and (2) these are the transects that are now being re-done.

Theta/Salinity/Sigma-theta sections

These long transects make the inter-ocean comparisons easy and clear.

The pressure axes are 0-6000 db (pressure expressed in units of decibars is numerically close to depth expressed in meters, so one can think of the vertical axes as depth from 0-6000 meters without any significant error). Oceanographers doing this type of work can measure pressure to an accuracy of about 0.2 decibars.

Potential temperature (often abbreviated with the Greek letter theta by oceanographers) is simply measured water temperature with a minor correction made to account for some effects of pressure on the measurement of temperature. Oceanographers doing this type of work can reliably measure differences of temperature of as small as about 0.002 °C.

Salinity can be thought of as a measure of the salt content of seawater. Oceanographers doing this type of work can reliably measure differences of salinity of as small as 0.0002 percent.

The density of seawater is a function of it temperature (density decreases as temperature increases), salinity (density increases as salinity increases), and pressure (density increases as pressure increases). Oceanographers do not usually measure density. Instead they calculate it from pressure, temperature, and salinity using an algorithm derived from very careful laboratory experiments. Oceanographers usually remove the pressure term mathematically, and then write the resulting number in a shorthand by subtracting 1000 kg m^{-3}. In other words, water with a density of 1027.5 kg m^{-3} at sea surface pressure would have a *sigma-0* of 27.5, and water which had a density of 1045.9 kg m^{-3} at 4000 decibars (a little shallower than 4000 meters) would have a *sigma-4* of 45.9. Density is of special significance to oceanographers because it provides essential clues to how water is moving. It is also much easier to mix waters of the same density than waters of different densities, and so density provides clues as to how different waters might be mixing.

The plot of potential temperature (blue for cold, red for warm) shows what we expect for the surface waters: warmest in the tropics and coldest in the polar regions.

Along with the plot of salinity (orange for salty; blue for fresh) this shows quite dramatically that the North Atlantic Ocean is overall the saltiest and warmest of the oceans.

The Mediterranean Sea (not on this plot) takes relatively fresh surface waters in and returns very salty water to the Atlantic. The Nordic Seas take in relatively salty surface waters, cool them, and return them at great density; filling the deep North Atlantic with dense salty waters.

At any given level, the densities of the Arctic Ocean and Nordic Seas (not shown) are the greatest in the World Ocean due to their unique combination of cold and salt. They can sink to the bottom there, but the Greenland to Scotland Ridge retains the densest waters north of Iceland. Some very dense, cold, salty water does spill out into the North Atlantic, and shows up on the bottom on the north end of the A16 Atlantic plot.

The huge upward adjustment in the density field where the Antarctic Circumpolar Current runs from west to east around Antarctica is easily the most impressive deformation in the density field.

Where Antarctic waters rise close to the surface around Antarctica, they are cooled and exchange gases. A huge tongue of relatively fresh intermediate water from the Antarctic region intrudes from the Antarctic into the South Atlantic at ca. 1000 meters. A similar but less dramatic tongue is found in the South Pacific.

A slightly more subtle deformation in the density field is seen in the bowl-shaped regions of less dense water in the upper layers in the subtropics of each of the oceans. Recalling that this is a transect through a three-dimensional ocean, one may be able to visualize that this is a response to the upper waters circulating in large "gyres".