NOAA Teacher at Sea
Scott Donnelly
Onboard NOAA Ship McARTHUR II
April 20 – 27, 2008

NOAA Teacher At Sea: Scott Donnelly
NOAA Ship McARTHUR II
Mission: Longitudinal Biological and Chemical Characterization of Coos Bay Line
Date: Thursday, April 24, 2008

Weather Data from the Bridge
Sunrise: 0620 Sunset: 2012

	WIND	SEAS	PRECIPITATION
AM	SW 5-15 kts, becoming 10-15 kts	Waves 2ft, W Swell 3ft @ 9 seconds	Rain showers possible
PM	S 5-10 kts,	Waves 2ft, W Swell 4ft @ 10 seconds	Same

Legend: kts = knots

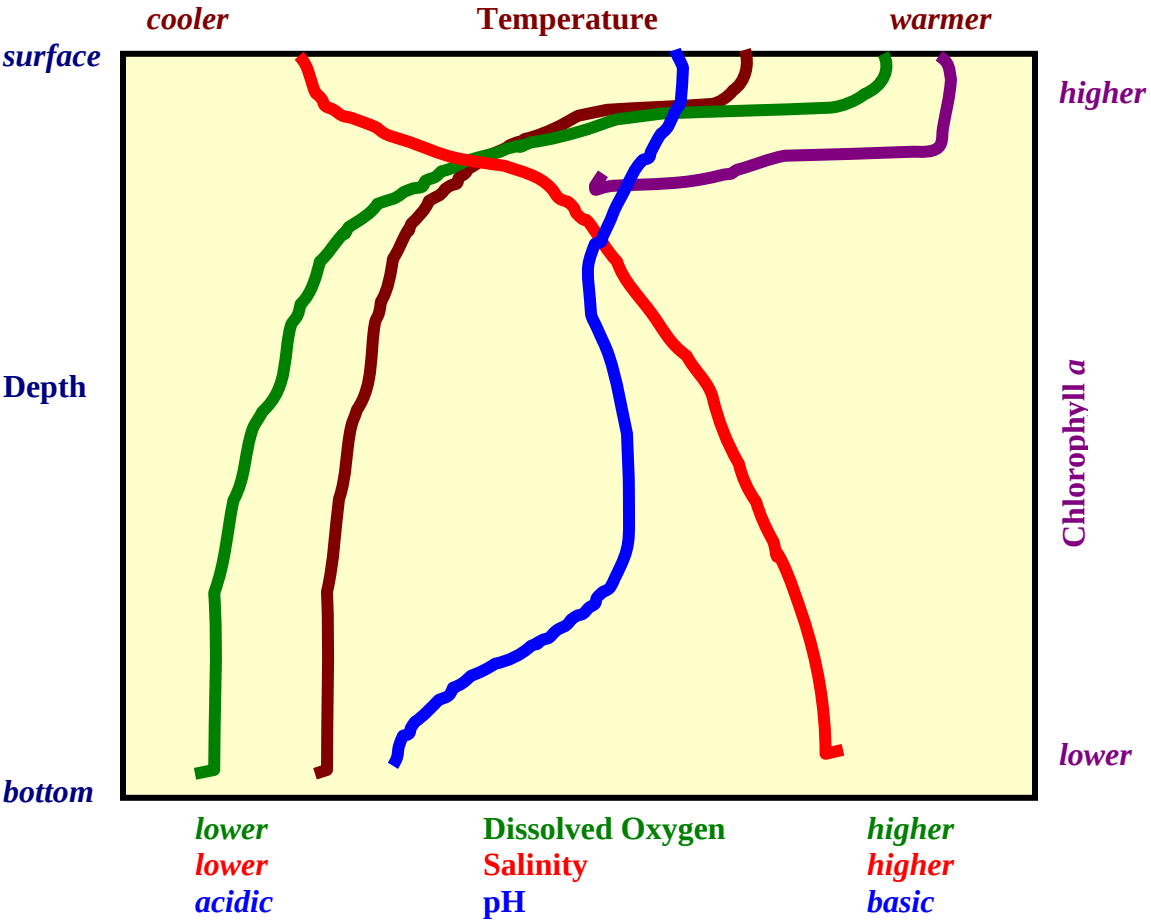
Science and Technology Log
As forecasted for Wednesday night the turbulent seas have calmed and the howling winds coming from all directions have subsided. On occasion a large wave smashes into the ship broadside. But, for the most part, it seems like the storm has moved onto land. Sampling operations restarted around 2000 (8pm) last night. This morning from 0100 to 0500 is my sixth 4-hour shift. Today nearshore and offshore CTD and biological sampling continues at different longitudes $124^{O}29'$W to $125^{O}15'$W but constant latitude $43^{O}07'$N. This is called a longitudinal sampling survey. The latitude and longitude coordinates align with the westward flow of water from Coos Bay estuary in Coos Bay, OR. Along these coordinates CTD deployment will reach depths as shallow as 50m (164ft) to as deep as ~2,800m (~9,200ft)! Round-trip CTD measurements will take more time due to progressively greater depths with increasing distance from the OR coast. On my morning shift we collected samples at two stations. At the second station 30 miles from the coast the CTD was deployed to a depth of 600m (1,970 feet).

Water collection from Niskin bottles

Monitoring CTD data

During Thursday's afternoon shift (my seventh 4-hour shift) the CTD was lowered to a depth of ~2,700m (~8,860 feet) located 50 miles from the coast. At this distance out at sea, the coastal landmass drops below the horizon due to the curvature of the earth and the up and down wave action. The round-trip CTD deployment and retrieval to such great depths take about two hours to complete. The dissolved oxygen (DO) probe measurements indicate a secondary DO layer in deep water.

So how are the continuous data measured by the CTD organized? What are the trends in data? In science graphs are used to organize numerical data into a visual representation that's easier to analyze and to see trends. Below is a representative drawing of how CTD and wet lab data are organized and presented in the same visual space. Note the generous use of colors to focus the eyes and show the differences in data trends.



What are some trends that can be inferred from the graph above? First, with increasing depth, seawater becomes colder (**maroon** line) until below a certain depth the water temperature is more or less at a constant or uniformly cold temperature (compared to the surface). Second, the amount of dissolved oxygen (DO) in seawater (**green** line) is greatest near the surface and decreases, at first slightly then abruptly, with increasing depth below the surface. Third, salinity (**red** line), which is directly related to conductivity, increases with increasing depth. Furthermore, in general seawater pH (**blue** line) becomes more acidic (and conversely, less

basic) with increasing depth. Last, marine photosynthetic activity as measured by chlorophyll *a* in phytoplankton (**purple** line) is limited to the ocean's upper water column called the photic zone. Below this depth, sunlight's penetrating ability in seawater is significantly reduced below levels for photosynthesis to be carried out efficiently and without a great expense of energy.

The consistently low (acidic) pH measurements of deep water collected by the Niskin bottles and analyzed on deck in the wet lab are a concern since calcium carbonate ($CaCO_3$) solubility is pH dependent. On this cruise the pH measurements between surface and deep waters show a difference of two orders of magnitude or a 100 fold difference. Roughly, pH = 8 for surface water versus pH = 6 for deep water offshore. This difference in two pH units ($\Delta pH = 2$) is considerable as it indicates that the deep water samples are 100 times more acidic than the surface water. pH is a logarithmic base ten relationship, i.e. pH = -log [acid] where the brackets indicate the concentration of acid present in a seawater sample. A mathematical difference in two pH units ($\Delta pH = 2$) translates into a 100 fold ($10^{\Delta pH} = 10^2$) difference in acid concentration. Refer to the Saturday, April 19 log for a discussion concerning the importance of $CaCO_3$ in the marine environment and the net acidification of seawater.

Personal Log

After the morning shift but before a hearty breakfast of eggs, hashed browns, sausage, bacon, and juice, I hung out on the ship's port side to watch the sunrise, a memorable mix of red, yellow, and orange painting the sky. It was one of the best sunrises I remember and that's saying a lot since I live in southern Arizona, where the sunrises and sunsets are the stuff of legends. With the low pressure system having moved over land, the sea was calm and the temperature considerably warmer with no clouds positioned between it and the ocean.

Perhaps surprisingly, I haven't sighted a whale or a whale spout, even in shallower, more nutrient-rich coastal waters. It's not that I haven't looked as each day I've visited the flying bridge (observation deck) above the operations bridge enjoying the immensity of the vast Pacific.

A flock of albatross have begun following the ship I suspect in hopes of getting a fish meal, mistakenly thinking that the McARTHUR II is a trawler.

I saw trash, which I couldn't identify without binoculars, floating on the surface. Sadly, even the vast, deep oceans and its inhabitants are not immune from humanity's detritus. The history of humanity and its civilizations are intimately linked to the world's oceans. This will not change. Humanity's future as well is linked to its maritime heritage. The oceans have fed us well and have unselfishly given its resources without complaint.

Perhaps it's time we return the compliment and lessen our impact.