.
Log 5 Tuesday

062100Z September 2005
2. Position: Lat: 9-53.0N LONG 146-09.6W
3. Course: 134-T
4. Speed: 10.5 kts
5. Distance: 240.9 NM
6. Steaming Time: 23H 0M
7. Station Time: 0H 0M
8. Fuel: 4613 gals
9. Sky: Cldy; As, Ac, Cb, Sc
10. Wind: 290-T, 08 kts
11. Sea: 290-T, 1-3 ft
12. Swell: 050-T, 5-7 ft
13. Barometer: 1009.1 mb
14. Temperature: Air: 27.4 C, Sea: 28.5 C
15. Equipment Status: No change.
16. Comments: Enroute to 1st station. Advanced clocks one hour to conform to (+9) time zone.

MASTER, R/V ROGER REVELLE

This cruise encompasses aspects of biology, chemistry and geology. We will be sampling for iron, salinity, Silica, Iron and Aluminium in seawater. So what do these chemicals have to do with those cute little plankton????? Well, I am so glad you asked…..here is a brief (and I mean brief) outline of ocean chemistry, with some additional sites to visit for imformation. It also has a wonderful little demonstration to do in the classroom to illustrate how this works in an ecosystem.

We will be taking our water samples using the CTDs, (Conductivity, temperature and depth rosettes) This package has a series of large tubes referred to as bottles, that are electronically "tripped" to close at various depths and take water samples. The one that Dr. Measures is using, is for Iron and Aluminium analysis. The other one is being used for Silica and nutrients.


Dr. Measures and his CTD for Fe and Al sampling


Brian stands next to the larger CTD in the staging bay

The Basics of Ocean Chemistry: The Basics of Ocean Chemistry, Carbon and Critters

Information from:

http://oceancolor.gsfc.nasa.gov/SeaWiFS/TEACHERS/CHEMISTRY/

The major ions in seawater are Na^+, Mg^{2+}, Ca^{2+}, K^+, Sr^{2+}, Cl^-, SO_4^{2-} (sulfate), HCO_3^- (bicarbonate), Br^-, $B(OH)_3$ (boric acid), and F^-. Together, they account for almost all of the salt in seawater.

Seawater Composition

Constancy of Composition:
Ratios of major elemental ions remain constant, despite changes of salinity (i.e., the amount of water is different).

Why Calcium is More Variable
Some phytoplankton (the foraminifera, coccolithophorids, pteropods, and heteropods, and also corals and coralline algae) form $CaCO_3$. The formation of $CaCO_3$ organically or inorganically (evaporation) can locally affect Ca concentrations, particularly in shallow waters. The dissolution of $CaCO_3$ in some regions can also affect Ca and CO_3^{2-} concentrations.

A Brief Summary of Carbonate Buffer System Chemistry

Atmospheric CO_2 dissolves in seawater and is hydrated to form carbonic acid, H_2CO_3. Carbonic acid is divalent; that is, it can undergo two de-protonation reactions to form bicarbonate (HCO_3^-), and carbonate (CO_3^{2-}). The co-existence of these species in seawater creates a chemical buffer system, regulating the pH and the pCO_2 of the oceans. Most of the inorganic carbon in the ocean exists as bicarbonate (~88%), with the concentrations of carbonate ion and CO_2 comprising about 11% and 1%, respectively.

Organic Carbon

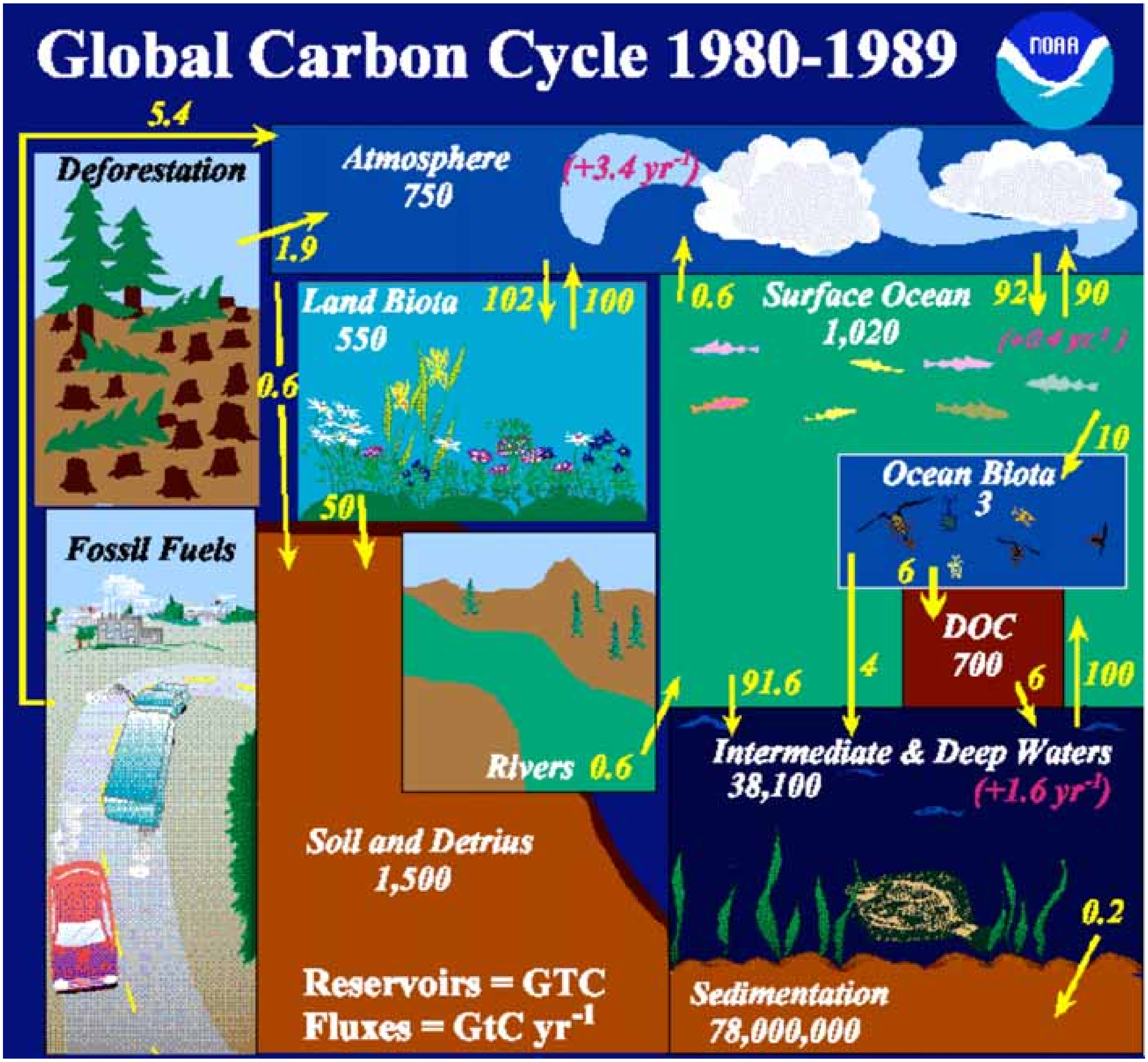
Dissolved and Particulate Carbon

The main other type of carbon in seawater are the forms of organic carbon, both dissolved and particulate. (It's primarily a matter of what can get through a filter of a certain size, and what can't.) Dissolved organic matter/carbon (DOM, DOC) can sometimes be colored (CDOM), and a variety of semi-polymeric DOC is termed *Gelbstoffe,* German for "yellow substance". Particulate organic matter/carbon (POM, POC) is larger organic particles from a variety of sources. SeaWiFS data is being used to calculate the amounts of CDOM (which may be correlated with total DOM) and POM in the water column.

Nutrients

Though small in concentration compared to seawater's major constituents, nutrients, primarily nitrate (N) and phosphate (P), are extremely important to the biology of the oceans. In some cases, iron (Fe) and silica (Si) may also act as limiting nutrients. The ratio of the concentration of carbon to nitrate to phosphate in phytoplankton is 106:16:1, which are the classic "*Redfield Ratios*". Chemical and biological oceanographers frequently analyze nutrient data with respect to the Redfield Ratios to determine which nutrient is the production-limiting nutrient. While Fe is important in some regions, particularly open ocean regions distant from land, in most productive regions the limiting nutrient is either N or P.

(N and P are actually present as dissolved nitrate ion and dissolved phosphate ion, but N and P are used for convenience.)



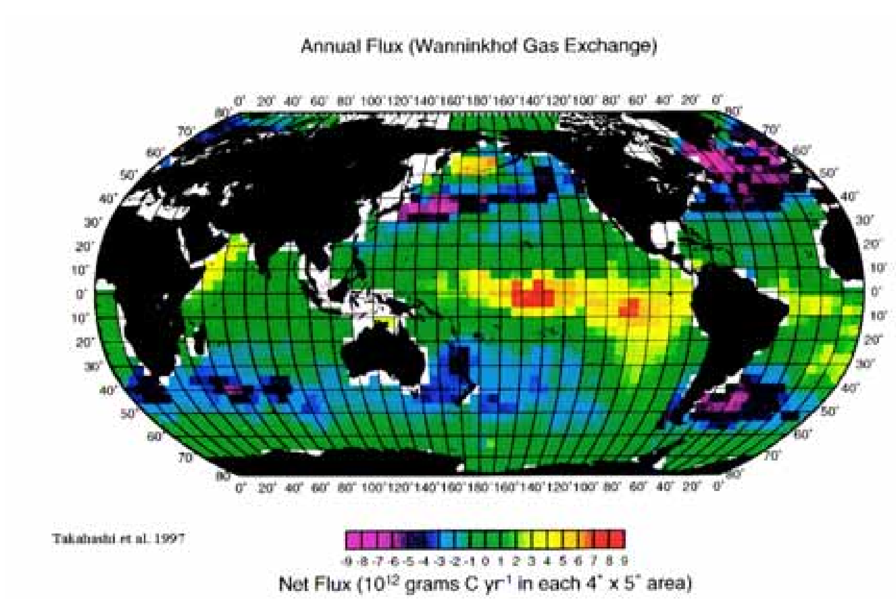
Marine Carbon Cycle

Carbon is produced in the upper ocean by photosynthesis, and it moves up the trophic levels (zooplankton, nekton). Most of the carbon in the upper ocean is recycled (the biologists can comment more on that), but some "drops out" and sinks. In the deep ocean, organic carbon is "*remineralized*" by bacterial respiration (which uses dissolved oxygen), converting it back to inorganic carbon and also producing dissolved nutrients. You can see in the carbon cycle diagram that there is much more inorganic carbon in deep waters than in the surface ocean. This means that deep ocean waters also have higher N and P concentrations than surface waters.

A brief aside: are the oceans a net source or sink of CO_2?

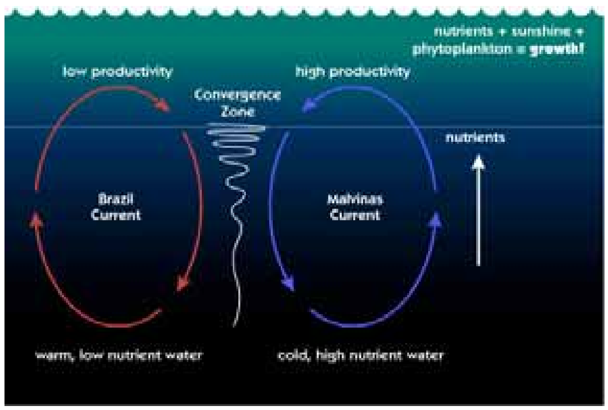
One interesting question about the marine carbon cycle concerned whether or not the oceans are a source of CO_2, adding it to the atmosphere, or a sink, removing it from the atmosphere. Recent research indicates that the oceans are a net sink, though some regions (generally colder and more turbulent) absorb CO_2, and other regions (warmer and less turbulent) release CO_2. The North Atlantic Ocean accounts for about 60% of the CO_2 absorption by the global ocean. (CO_2 is less soluble in warm water than in cold water.) For a variety of reasons, global warming could convert the oceans from a sink to a source, which is an example of bad positive feedback.

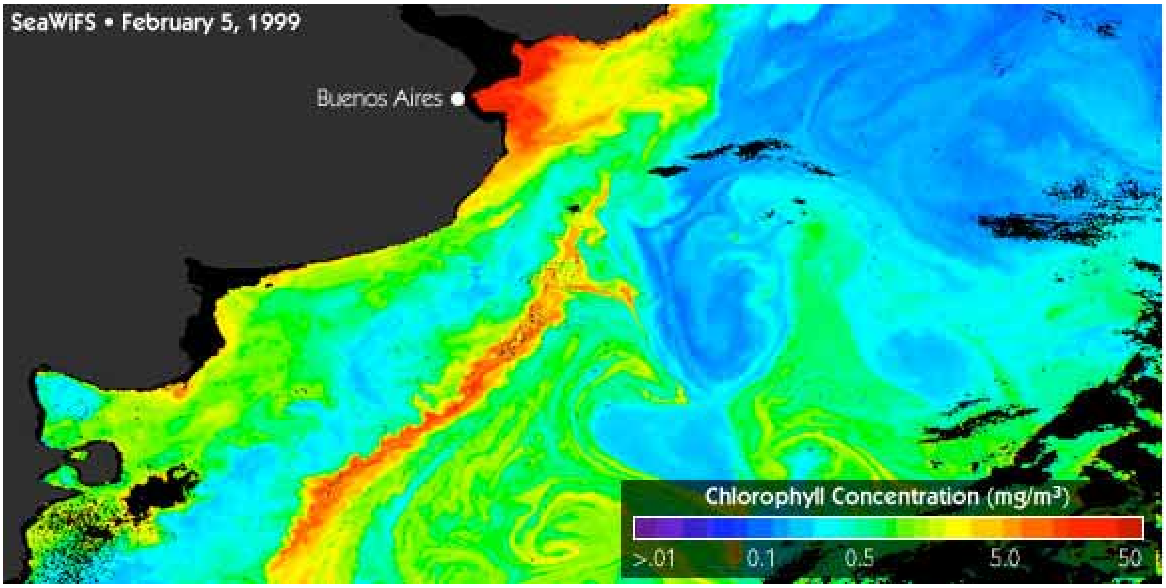
Annual CO_2 Flux



PHYSICS + CHEMISTRY = BIOLOGY

Now for the culmination of the process. In certain regions of the ocean, current interactions with the coast, or current interactions with other currents, or both, bring the cold deep nutrient-rich ocean water to the surface, a process called "*upwelling*". Add sunlight and plankton, and photosynthesis and productivity result. The high productivity in these regions is easily seen in SeaWiFS data.





TOO MUCH IS NOT A GOOD THING, and a demonstration

Finally, in some regions (particularly near major rivers), excess nutrients can be added to the coastal zone. This is usually not good, because it results in increased productivity, increased sedimentation of organic matter, and increased bacterial respiration, resulting in a marked reduction of dissolved oxygen, especially on the bottom, which can kill the biota on the bottom. The term for this overabundance of carbon and lack of oxygen is "*eutrophication*".

Demonstration (or experiment):

Go to a nearby stream or pond and scrape some of the algae off the rocks. "Inoculate" a series of clean baby food jars with the algae. Set one baby food jar aside as a control, and add increasing amounts of Miracle-Gro or similar fertilizer. (A very small amount suffices -- the amount you can pile on the end of a coffee stirrer is enough!) I suggest one control and three jars with 1 portion, 2 portions, and 4 portions of the fertilizer. Put the jars in a sunny place.

Monitor daily (taking comparison photographs each day is a good way to do this). What you'll see is that algal growth will be enhanced in the fertilized jars compared to the control, but in the over-fertilized jar, growth will be rapid and then the algae will turn brown and die - that's what happens with eutrophication.

Dinner was lamp chops and Linguini in clam sauce! More science tomorrow…..stay tuned!!!