Subject: Scholes cabin 5: Oxygen and Argon

13 December 2009 11:41 UTM 45.3286 S 5.6314 E

Dear Stirling,

In the past, oceanographers (scientists who study the ocean) mainly formed two 'gangs': physical oceanographers who study currents, waves and salinity and that sort of stuff; and biological oceanographers who looked at plankton and corals and fishes and other living things.

They often disagreed about what was most important. Take the ocean carbon sink, for instance. The physical oceanographers used to argue that it was pure chemistry and physics at work - the atmosphere had a higher partial pressure of carbon dioxide because we were dumping it there, so it would dissolve in the seawater until the ocean and atmosphere were in balance again. The biologists said 'Nonsense! The top layer of the ocean would soon saturate (fill up) with dissolved carbon dioxide, if it were not for the phytoplankton gobbling it up and exporting it to the deep oceans in their dead bodies'.

Like most arguments of this sort, they are both right and both wrong, because both processes are important, but to different amounts in different places and time. Science has made enormous progress by splitting ideas up in our heads. This is called Reductionism: trying to understand all the parts of a complicated process separately. But we often forget that in reality they work as one, interconnected system. It is like taking a watch apart and then not putting it back together. I am a 'systems ecologist', in other words, someone who specialises in putting the bits together.

This was a long background to the reason for the other main instrument in my lab, which is a mass spectrometer. It is able to measure the relative quantities of atoms of different weights, very accurately. For instance, an oxygen atom weighs 16 (I won't bother you with the units), but they always hang around in pairs, so O2 weighs 32. Argon (Ar), a trace gas in the atmosphere that has a very similar solubility to oxygen, weighs 40. This provides a clever way of solving the physics versus biology fight at any given place or time. The uptake of Ar by the ocean is just due to physics, since it is 'inert'; in other words, it does not react with anything. Oxygen is affected by both physics and biology (I will explain the biology bit some other time). So changes in the ratio of O2:Ar in seawater, relative to O2:Ar in the atmosphere, tell us about which process is dominant.

The 'mass spec' is rather finicky, and I am a bit scared of it. We pass seawater through an 'equilibrator' which causes the O2:Ar in the head-space of the same chamber to

come into balance with the seawater. Then we sip a tiny amount of the air through a glass straw finer than a human hair, and put it into a vacuum, where we accelerate the atoms with electricity, and bend them with a magnet. The heavy ones can't turn the corner as well as the light ones, and crash into the railings in a different place. We count the crashes and work out their ratio. It is really accurate, but you have to be very, very nice to it.

We are almost exactly halfway between the equator and the South Pole, and about a third of the way between Cape Town and Antarctica. It is starting to get cool, and the water is really cold - around 10 degrees Celsius.

Love to Mom and yourself,

Dad