A16S Chief Scientists' update #3. Jan. 12, 2014

The weekly report and additional pictures from the cruise can be found at:

http://www.aoml.noaa.gov/ocd/gcc/A16S_2014 bottom left hand under "During-Cruise"

A changing ocean.

This week has gone well with nice weather and calm seas, and only minor operational issues. We are steaming across the South Atlantic subtropical gyre and are now at 35 South about to depart from a due South course along 25 West to one South to South-West following the center of the Brazil/Argentine basin.

The big news of the week was that there was a miscalculation of the coffee consumption on the ship and that coffee has to be rationed. Coffee is now stored in a secure locker with 2 pounds dispensed for every shift. Rumors have it that the trace metal group has a stash of good Hawaii Kona coffee and negotiations are underway to give the group more wire time in exchange for a morning brew for the chief scientists.

The subtropical gyres are vast expanses of generally calm blue waters devoid of much marine life. We were visited by some Shearwater, elegant birds that glide right above the waves for miles while following the ship. Last night the night crew saw luminescent squid but since the topic of discussion at the dinner table has been how good fresh calamari would taste, [the day crew] wonders if it was a hallucination.

While at first glance the gyres appear untouched by mankind, a closer look shows a different picture. These gyres act as a vortex and trap materials. The North Pacific gyre has been called in the popular press "the Great Pacific Garbage Patch". It is a region that accumulates marine debris in the central North Pacific Ocean while the Sargasso Sea in the North Atlantic traps materials in the same fashion. The South Atlantic gyre, far removed from population centers, is less impacted but it is disconcerting that almost every day we see plastic debris floating in the water.

Less visible are the changes in the ocean that we are measuring but our instruments are telling a story of change. One of the major objectives of the repeat hydrography program is to determine the amount of the greenhouse gas, carbon dioxide (CO_2) from burning of fossil fuels that is entering the ocean. This quantity is of critical importance to estimate future atmospheric CO_2 levels. The increasing CO_2 levels in the ocean also have a detrimental effect for marine biota, a phenomena often referred to as ocean acidification. The NOAA ship *Ronald H Brown* carries an automated instrument that measures atmospheric CO_2 and surface ocean CO_2 levels continuously. The instrument on this ship along with those on several dozen other ships of opportunity world-wide provide us a picture of the varying patterns and trends of the increasing CO_2 levels around the globe.

The attached graph (figure 1) provides the current CO_2 data along the cruise track and the two previous occupations in 1991 and 2004 that one of us (RW) participated in. The CO_2 released by

burning of fossil fuels mixes rapidly around the globe and atmospheric concentrations are increasing everywhere at a similar rate. The atmospheric CO_2 levels over the South Atlantic follow the well-measured global trend with levels increasing from 344 parts per million (ppm) in 1991 to 394 ppm on the current cruise, or an increase of 10 % in two decades. The surface water levels show the expected increases from sequestration of CO_2 from the atmosphere, but also show significant spatial variability caused by temperature and biological variability in the ocean. Our challenge is to unravel the changes in ocean carbon content due to physical and biological processes from the CO_2 entering from the atmosphere.

Currently we are doing a CTD cast at Station 59. Deploying the CTD and Trace metal CTD/Rosette packages (see figure 2) and sampling of the bottles on the CTD package are becoming routine (see figure 3). The weather continues to be nice with calm seas but the long range weather forecasts down the line look ominous. All is well onboard and we have passed the halfway mark with only 53 more stations to go!

Rik & Leticia,
Chief scientists GO-SHIP/CLIVAR A16S

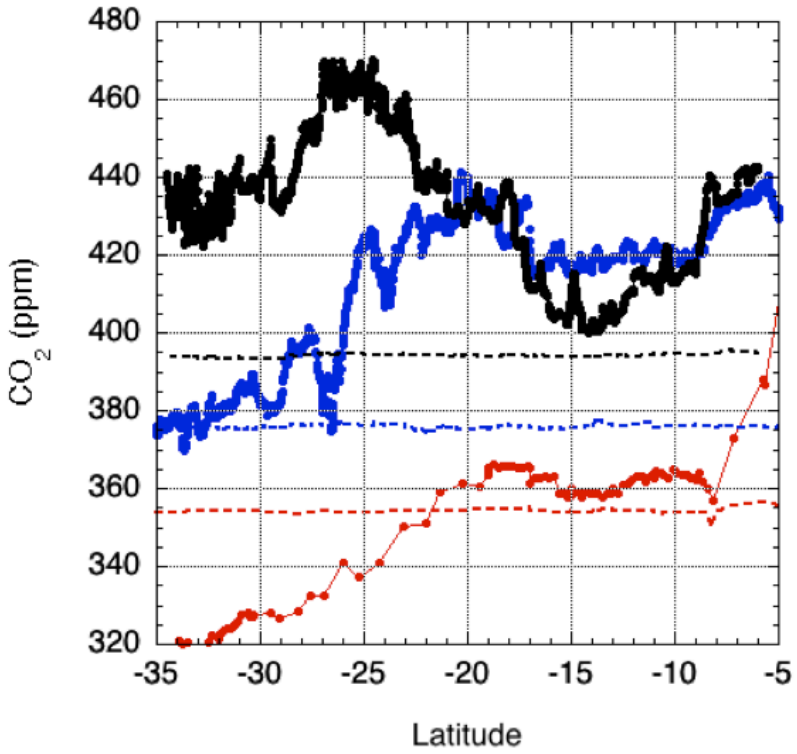

Figure 1: Results from the underway pCO_2 system that measures atmospheric and surface ocean CO_2 levels. The red points are from August, 1991, the blue points from February 2003; and the black points are the data from this cruise in 2013. The dashed lines are the atmospheric levels that are continually increasing due to burning of fossil fuels. The solid lines are the surface water CO_2 levels. When the surface water levels are higher than the atmosphere the ocean releases CO_2 (it acts as a source); when it is lower it absorbs CO_2 (it acts as a sink). During the

summertime the tropics and sub-tropics are generally CO_2 sources as seen in the figure, while at higher latitudes the ocean acts as a sink but with appreciable seasonal and spatial differences. The instrument on the Brown, maintained by the chief survey technician on the *Ronald H. Brown*, J. Shannahoff, sends the data automatically to shore via satellite/internet. Staff at AOML provide shoreside support with funding from the NOAA Climate Observation Division.

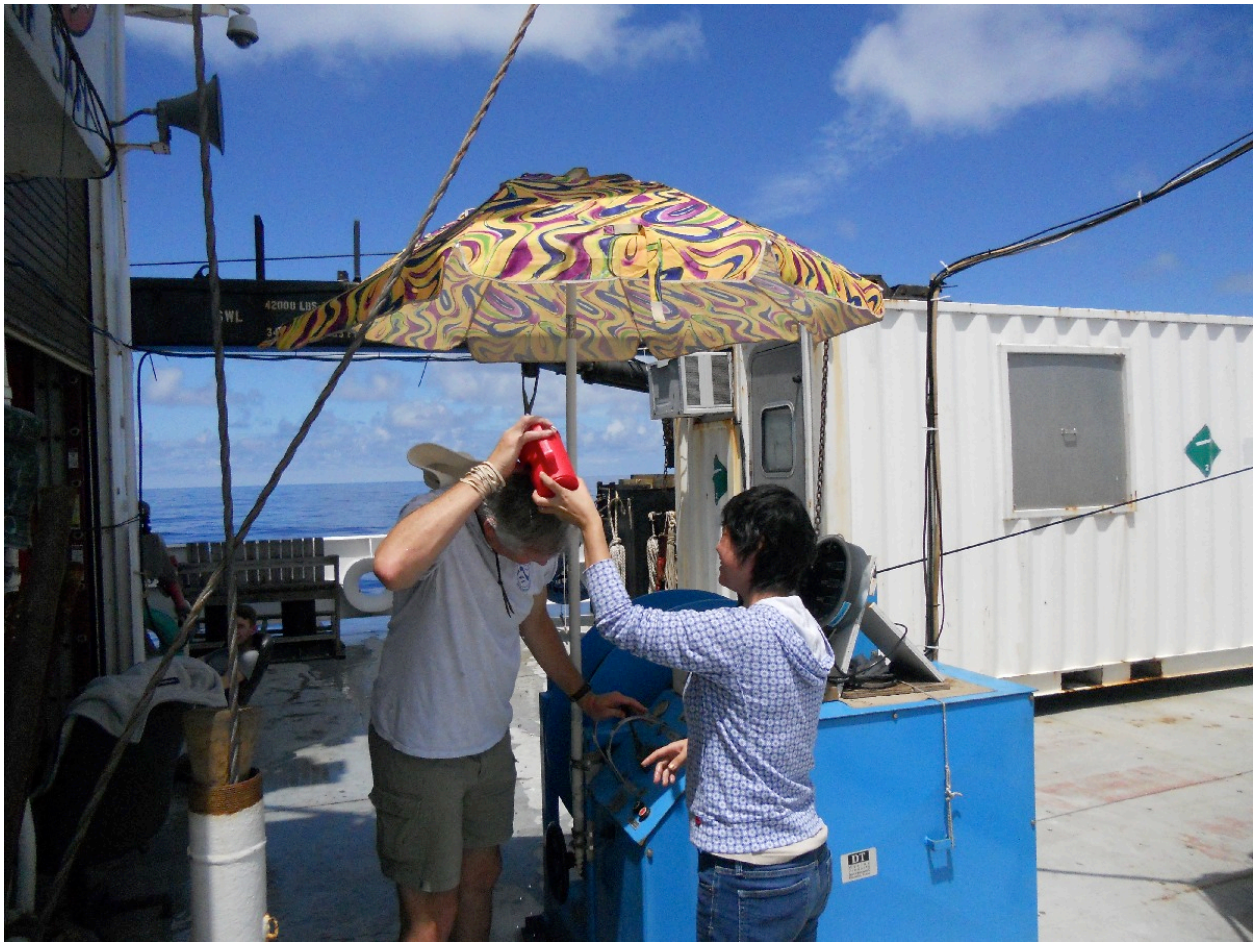

Figure 2: The trace metal group use a special winch and cable for the CTD/Rosette/sampling bottle package to avoid low level contamination of iron and other metals that are common from the larger CTD package and cable. Here, Bill Landing (FSU) is doused with cold water by Mariko Hatta (U. Hawaii) while operating the trace metal winch that is located on the aft deck.

Figure 3: Sampling of the main sampling bottles is organized chaos with up to 8 persons sub-sampling the bottles with their own specialized containers. Since samples degrade or get contaminated at different rates after opening the bottles there is a designated order of sampling and rapid sampling is required. The skills of sampling are sometimes passed on over generations. Here, Eric Wisegarver (PMEL) is being trained to use large syringes to subsample for Freons while David Wisegarver (PMEL) is overseeing proper sampling procedures. In the background Andy Stefanick (AOML) is sampling for oxygen [the sunglasses are to avoid seeing unwanted bubbles in the sampling flasks…], while Bob Castle (AOML) is waiting for his sample for dissolved inorganic carbon. Gloves are worn to avoid contamination of samples for organic carbon in seawater taken later in the sampling sequence.

CTD: conductivity/temperature/depth profiler
AOML: Atlantic Oceanographic and Meteorological Laboratory of NOAA
PMEL: Pacific Marine Environmental Laboratory of NOAA
FSU: Florida State University
U. Hawaii: University of Hawaii