SONNE 243 Weekly Report I

Today is Sunday 12. October 2015 and the first week of the SO243 cruise is almost over. This week has seen a variety of activity, something very typical for a biogeochemical research cruise. We are in the eastern tropical South Pacific Ocean, studying the effects of oxygen minimum zones on biogeochemical cycling in the surface ocean and air-sea gas exchange. On board are chemical, biological, and physical oceanographers, atmospheric chemists, and atmospheric physicists studying a variety of trace gases in the ocean and atmosphere and the biological, chemical and physical processes that influence their production, loss, and air-sea exchange.

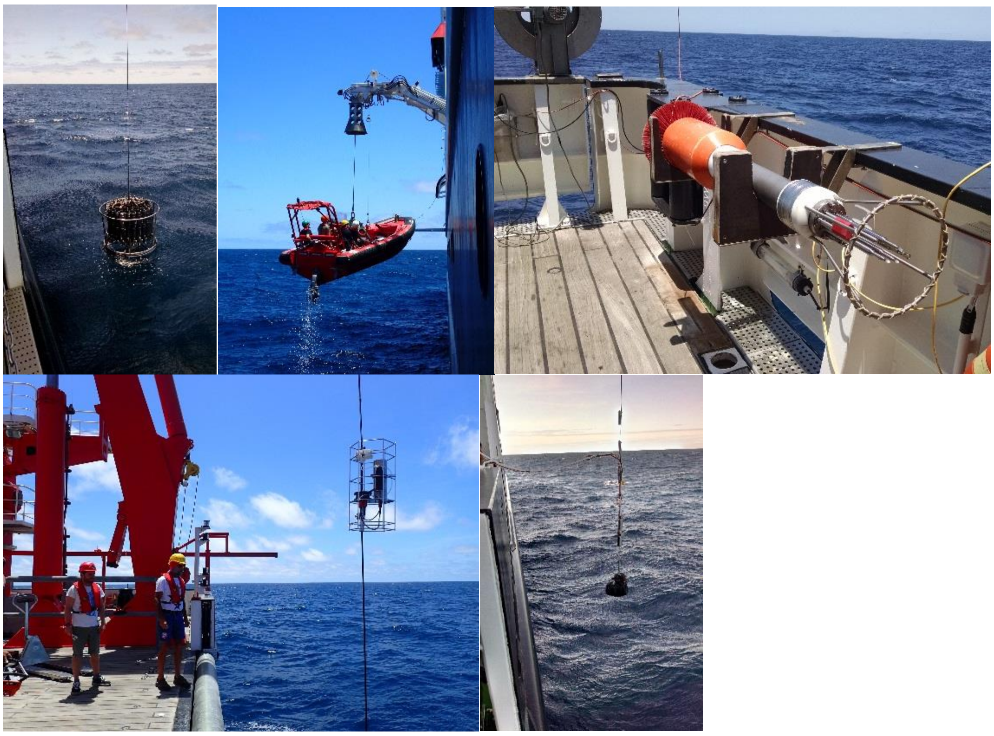

Figure 1. Top row from left: CTD rosette, Zodiac, microstructure sonde; bottom row from left: particle pump, continuous profile pump (C. Marandino, I. Rapp)

In the first week we had 7 stations involving multiple CTD casts, RAMSES deployments, Zodiac sampling, microstructure sonde deployments, Go-flo casts, particle pumps, and a continuous profile pump (Figure 1).The stations have been a bit energetic; with 37 people on board during a 17 day cruise, it is a challenge to meet their water sampling needs while trying to save time to make it to Antofagasta. But between Damian G., Toste T., Rudi L., Lothar S., and Tim F. we have a crack CTD team. Most deployments have been successful and the preliminary data is already being produced (Figure 2).

One highlight of the week was our eddy hunt. Eddies are rotating mesoscale structures in the ocean that contain different water properties than their surroundings. Recently, eddies have been identified as low oxygen natural laboratories, in which we can investigate how the biogeochemistry is different from the surrounding waters. The eddy we found was a 10°S, 82°W and was a normal anticyclonic eddy (Figure 2). The oxycline was found at 20m and the levels went down to approximately 50 µmol/l. The effect of the lower oxygen concentrations can be seen in both the nitrous oxide (N_2O) profile and the carbonyl sulphide (OCS) profile in the right panel in Figure 2.

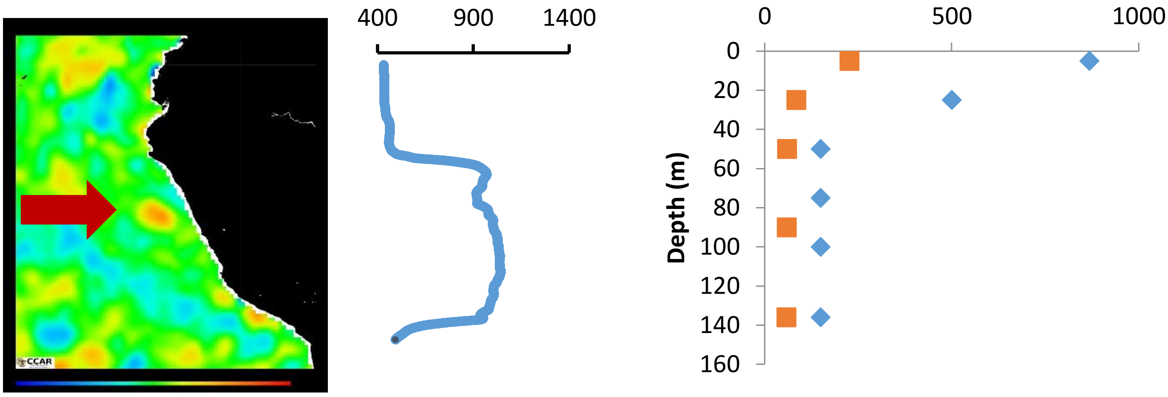

Figure 2. Left) location of sampled anti-cyclonic eddy; middle) N_2O seawater values (ppb equilibrated air) vs. depth in eddy; right) O_2 (µmol/L,orange), OCS (ppt equilibrated air, blue) vs. depth in eddy.

In addition to the station program, we are performing a variety of underway measurements from the moon pool pumping system, a trace metal clean tow fish, and in the atmosphere. These include discrete sampling for chemical and biological parameters, as well as continuous equilibrator based chemical measurements, radio- and ozonesondes, air canister sampling, and direct flux measurements using the eddy covariance technique (Figure 3).

Figure 3. From left) continuous underway seawater equilibrator, radiosonding with a fishing pole, eddy covariance mast. (C. Marandino, T. Tanhua)

Despite the flurry of activities, we have still managed some time for amusement: after the first 3 stations, we had a little ice breaker; and the crew was kind enough to show us around the massive engine rooms of the new R/V Sonne (Figure 4).

Figure 4. Left) ice breaker; right) engine tour. (C. Marandino, S. Endres)

Thanks to the hard work of all the scientists, and especially the captain and crew, the first week ended well!

Greetings from the Pacific, Christa Marandino and Damian Grundle

SONNE 243 Weekly Report II

This week started out with a rather large challenge to overcome: we ran out of liquid nitrogen. Given that approximately 1/3 of the cruise participants depend in some way on measurements made with liquid nitrogen, plus others use liquid nitrogen to flash freeze samples, this was a serious concern. It was a hard call, but we decided to risk our schedule and go to port in Chimbote, Peru to buy 140 L of liquid nitrogen. It was a very tense time, considering that everything took much longer than planned and we only have a 17 day cruise. But, finally, on Tuesday, we obtained our goal (Figure 1)! Better late than never, as they say…Special thanks to the captain, crew, Wilson Carnhuapoma (a Peruvian scientist on board from IMARPE), and Damian Arevalo for their efforts to acquire the liquid nitrogen.

Figure 1. Left) one view of the area around Chimbote from the ship, Right) liqud nitrogen delivery (R. Link, C. Marandino)

Despite the loss of time, we have been able to recover our science plan. During this week, we performed three deliberate tracer releases (Figure 2). The Ocean Tracer Injection System (OTIS) team, led by Toste Tanhua, injected 68.5 kg of the inert tracer CF_3SF_5 into the bottom boundary layer at three sites along the Peruvian shelf. The OTIS is designed to be towed behind the ship at a set density surface. However this time we wanted a tracer release very close to the bottom, so the OTIS got “legs” and “feet” so that we could deploy the OTIS on the bottom of the ocean and release the tracer there. The reason for the close-to-bottom release is that we want to mimic release of nutrients from anoxic sediments, and qualitatively understand where ocean currents and mixing processes distribute the nutrients (i.e. the tracer) over a longer time-period. Anoxic sediments are known to release nutrients, such as phosphate and reduced iron, both of which have the potential to enhance productivity in the region – and initiate a positive feed-back loop.

The distribution of the tracer will be measured by two additional cruises over the coming 18 months; the results should inform us about the mixing pathways of nutrients from sediments in the region. This experiment is a component of the proposed third phase of the SFB754 project “Climate-Biogeochemistry Interactions in the Tropical Ocean” that has a focus in the oxygen minimum zone off Peru, and the results of the experiment are expected to provide another piece of the puzzle on how the OMZ off Peru is operating.

Another challenge during our cruise has been to search for signs of upwelling during an especially intense El Niño year. El Niño forecasts to date show an SST anomaly of approximately 5˚C (warming). This warming signifies the weakening of upwelling closer to the coast. Although the OMZ in this region is always present, its location during an El Nino event is deeper in the water column. Both of these phenomena have an impact on trace gas production and air-sea exchange. The upwelling zone usually experiences high productivity, as enhanced levels of nutrients are brought to the surface, stimulating biological activity. For trace gases that are biogenic in origin, such as dimethylsulfide, isoprene, and bromoform, the weakening of upwelling means less production in the surface ocean and therefore potentially less air-sea exchange. Since the lack of upwelling means a deeper OMZ, trace gases

Figure 2. Left) the OTIS being lowered into the ocean, middle) Toste Tanhua and Tim Stöven working on the tracer tanks, right) Andreas Pinck and Mario Müller working on the OTIS (C. Marandino, T. Tanhua)

produced as a consequence of diminished oxygen, such as N_2O, will also be reduced at the surface. However, the signature of upwelling, as illustrated in the CO_2 and SST measured over the cruise track (Figure 3), can be seen in the most southern part of our trip. Cold CO_2 rich waters from deeper can be seen near the coast around 9˚S and extend away from the coast by 14˚S. Here we hope to find higher levels of trace substances and better track the processes that influence their cycling and air-sea exchange.

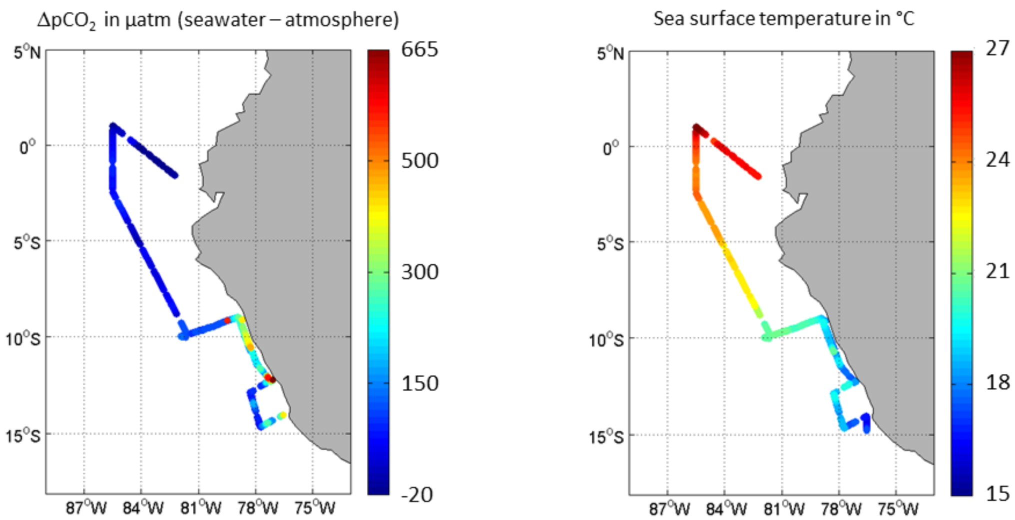

Figure 3. ASTA-OMZ cruise track to date: left) showing the difference between seawater and atmospheric levels of CO_2 (T. Steinhoff, D. Arevalo), right) showing sea surface temperature.

The upcoming final week of the cruise will occur in this more intense upwelling area. We are looking forward to our investigations there!

Greetings from the Pacific, Christa Marandino and Damian Grundle