LMG 24-01: PAL LTER Cruise 31
Weekly Science Report 3, 8– 14 January 2024

LTER: Ecological Response and Resilience to "Press-Pulse" Disturbances and a Recent Decadal Reversal in Sea Ice Trends Along the West Antarctic Peninsula

Week 3 overview (Dr. Deborah Steinberg, Chief Scientist):

In Week 3, we wrapped up sampling the 300 grid line, and then completed the 100 and 200 lines. Regular, standard station operations occurred at representative coastal, shelf, and slope stations along the lines, as well as underway sampling between the stations. We then conducted a High Resolution Survey of a coastal frontal region on the northwest coast of Adelaide Island. We subsequently deployed the birder team on Avian Island for the annual census and sampling of the Adélie penguin colony there. We finished the week conducting our second Process Study, with sampling and experiments (details in individual reports below) at a deep Marguerite Bay coastal station (200.000) followed by a third Process Study at a comparison outer slope water site (200.180). We deployed the drifting sediment trap (to measure export of sinking particles) and conducted day vs. night depth-stratified MOCNESS tows (to assess zooplankton diel vertical migration) in both the coastal Marguerite Bay submarine canyon and outer slope process study stations.

Group Reports

C- 021: Physical Oceanography (Dr. Carlos Moffatt, PI; U. Delaware)

Field Team Members: Michael Cappola (lead), Jake Gessay

This week, we worked on downloading data from the mooring sensors recovered last week and completed a high resolution CTD survey near Adelaide. The M-9 mooring sensor download went smoothly and all sensors survived the deployment. Below we see the transition of Antarctic Surface Water and Winter Water as the seasons progress (**Fig. 1**). It is amazing that we were able to recover this mooring at all: After downloading the pressure data from the top sensor, we discovered that the mooring was struck by icebergs, surviving 32 individual collision events (**Fig. 2**). This is evident in the pressure data from the top sensor showing sharp pressure (depth) excursions towards the end of the time series (**Fig. 2**). The ability of the mooring to withstand this is a testament to the sturdy design and excellent construction of our moorings as well as a healthy bit of luck. These data add another year to our long mooring time series at the 300.100 station, and we look forward to analyzing the data further.

On Jan. 10th we completed a high resolution CTD survey of the Antarctic Peninsula Coastal Current (APCC), which typically runs south along the western coast of Adelaide Island following the bathymetry. We successfully resolved this current during the LMG 2301 LTER cruise, so we decided to transit to the same location and resolve it again, but this time we intended to also collect a suite of biologically relevant parameters. We worked closely with the other labs onboard to collect samples for Chl-a, phytoplankton community structure by flow cytometry (IFCB), nutrients, carbohydrates, lipids, POC, D18O, and zooplankton. We completed a total of 7 CTDs close to the coast of Adelaide Island near the 300 line (**Fig. 3a**), with 3 of those also including the above suite of parameters. The zooplankton lab also did a pair of net tows at the beginning of the transect. The front was much weaker than last year, which is interesting and

indicates we don't fully understand the variability of this feature. Contour plots of temperature and salinity data from the high-resolution section are shown below (**Fig. 3b,c**).

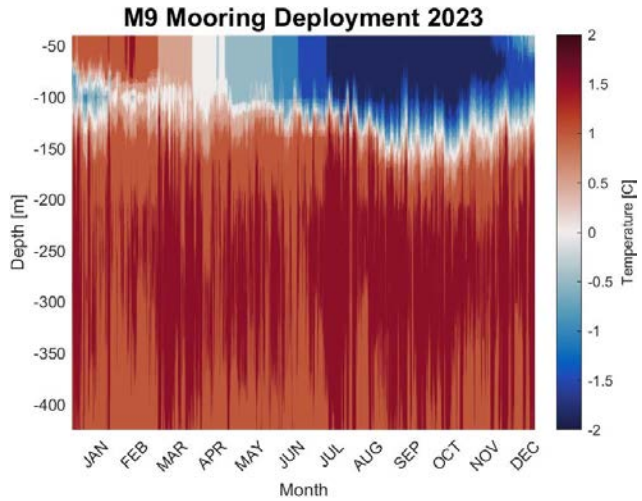

Figure 1. Temperature data from our M-9 Mooring Deployment. (Data preliminary).

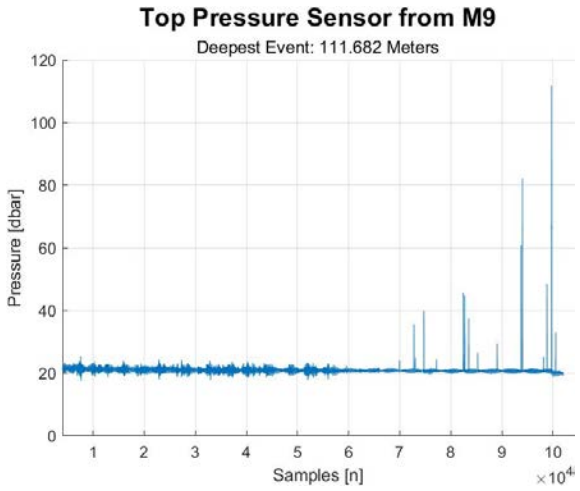

Figure 2. Pressure (depth) from the top (shallowest) pressure sensor of the M9 mooring. Spikes toward the end of the time series indicate iceberg strikes that pull the surface of the mooring deeper.

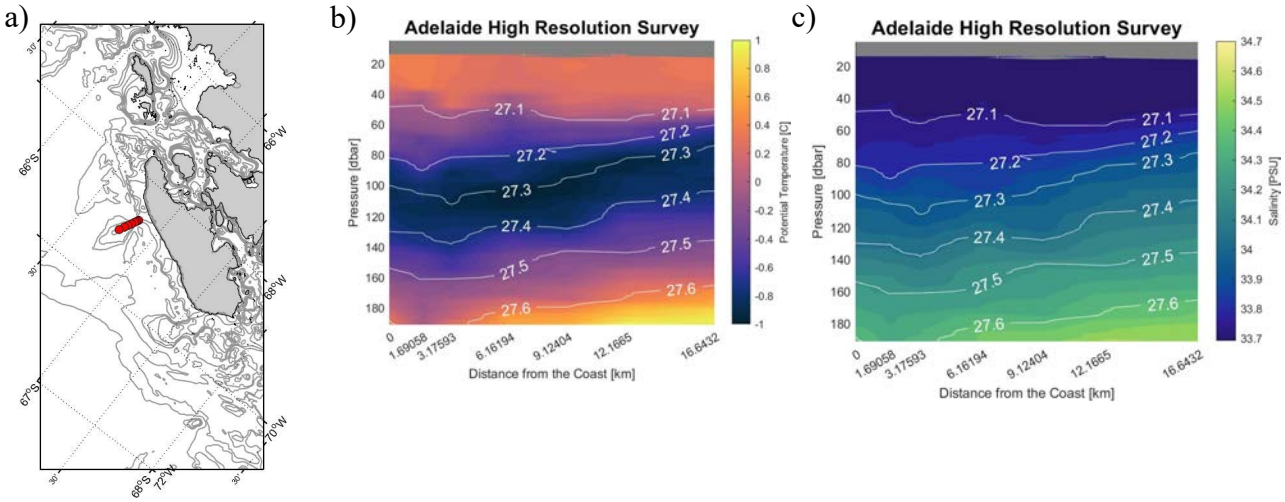

Figure 3: High resolution CTD survey of the Antarctic Peninsula Coastal Current (APCC) near the western coast of Adelaide Island. a) Map of survey with red dots indicating CTD cast locations. b) Temperature, and c) salinity contour plots with isopycnals (common lines of density) overlayed in white. Notice how the 27.2 and 27.3 lines are slanted, suggesting a weak front of the APCC. The left side of both contour plots is closest to the coast.

C-045: Biogeochemistry (Dr. Ben Van Mooy, PI; Woods Hole Oceanographic Institution)

Field Team Members: Zephyr Girard (lead), Hannah Goldberg, Dr. Laura Mota, Rachel Davitt

This week we continued along the regular LTER grid, sampling for particulate organic carbon, lipids, carbohydrates, nutrients, oxygen isotopes, flow cytometry, dissolved inorganic carbon and alkalinity. We also contributed to the high-resolution survey off the coast of Adelaide I. led by

the C-021 group by sampling for oxygen isotopes, flow cytometry, nutrients, lipids, carbohydrates and particulate organic carbon.

On Jan. 12, we deployed a Particle Interceptor Trap (PIT) at the 200.000 Process Station in Marguerite Bay which we recovered the following day (Jan. 13) (**Fig. 4**). Like our Palmer Deep sediment trap, we saw a high number of krill fecal pellets, however here we also saw many diatom chains which we had not seen previously. Today (Jan. 14) we deployed our third and final PIT trap at the 200.180 station which we will recover tomorrow after 24 hours. We look forward to comparing our coastal vs. offshore trap samples from 200.000 and 200.180 stations, as well as incorporating into our analysis depth-resolved zooplankton community structure determined by MOCNESS tows conducted by the zooplankton (C-020) group.

Figure 4. Recovering the sediment trap (Particle Interceptor Trap, PIT). Each cross frame holds nine tubes into which sinking organic particles are collected, and each sediment trap array collects these samples at 3 depths. The vertical array is attached to a surface float and drifts freely but with a satellite tracker so its position can be monitored. Photo by Laura Motta.

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C-019: Phytoplankton (Oscar Schofield, Rutgers, P.I.)

Field Team Members: Heather Forrer (lead), Jake Gessay, Mya Sharpe, Dr. Ahmed El-habashi

This week continued to be a busy week for the C-019 group, where we continued to sample the core phytoplankton time series measurements, including Chlorophyll-a and HPLC, photosynthetic quantum yields, and light absorption spectra of particulate phytoplankton pigments (**Fig. 5**). We also completed our second the 48-hour diel incubation started at Process Station 2!

Furthermore, the seas were in excellent condition for continuous operation of the HyperSAS. The HyperSAS collected spectra from the 100 and 200 lines, as well as the entire inshore 200.000 process station (**Fig. 6**). We serviced the unit this week and started uploading data for initial

analysis. We are hopeful for lots of phytoplankton in Marguerite Bay as we make our way to Rothera next week.

Particle size distributions measurements and above water radiometry (**Fig. 7**) are performed at each site. During each of the in-water optical casts performed at each site, inherent optical properties of the water the column were characterized, indicating the amount of phytoplankton, minerals, and dissolved matter in the water column (**Fig. 8**).

Figure 5: Sampling the CTD by graduate students Zephyr Girard (L) and Mya Sharpe (R). Photo by Debbie Steinberg.

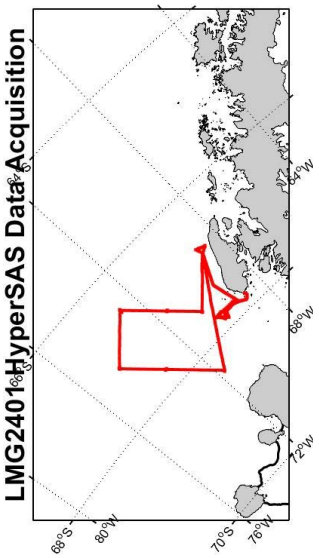

Figure 6. HyperSAS spectra acquition from the 100 and 200 lines, and 200.000 Process Study Station.

Figure 7. Ahmed El-Habashi performing above-water radiometry measurements. Photo by Debbie Steinberg.

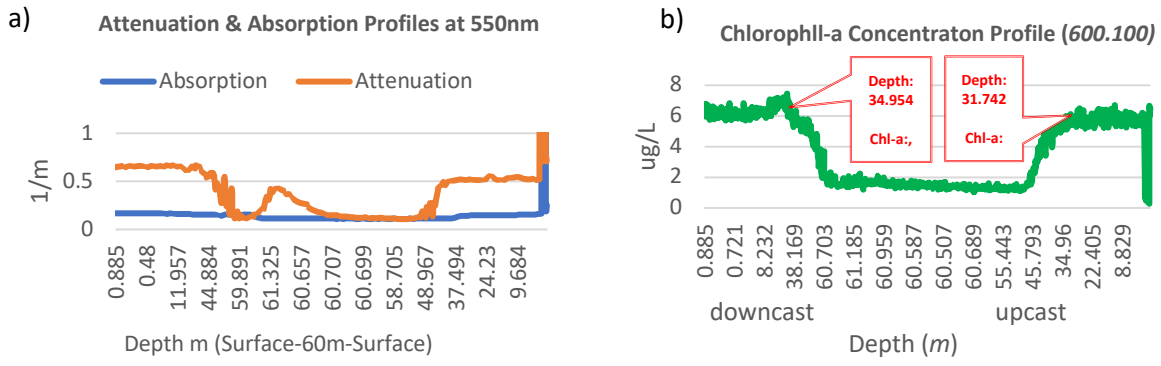

Figure 8. Hyperspectral profiles down to 60m of a) absorption (blue) and attenuation (orange) coefficients at 550nm, and b) chlorophyll-a concentration profile to 60m for station 600.100 including both the downcast and upcast. Higher attenuation is observed near the surface, after which it decreases below the mixed layer. Conversely, absorption remains consistent throughout the cast. Interestingly, an attenuation spike with fixed absorption values indicating higher scattering by small particles around the 60-meter depth was observed. Elevated chlorophyll-a values (~6 ug/L) were observed in the upper surface. The deep chlorophyll-a maxima (DCM), marked in red for both casts, delineates the decrease in chlorophyll-a values with depth (< 2 ug/L).

C-020: Zooplankton (Dr. Deborah Steinberg, PI; Virginia Institute of Marine Science)

Field Team Members: Deborah Steinberg (lead), Joe Cope, Meredith Nolan, Hannah Gossner, and Connor Shea

In this third week, we wrapped up our zooplankton net tow sampling for the 300 grid line, and then completed the 100 and 200 grid lines. The Antarctic krill *Euphausia superba* is still dominating the catch, especially at the coastal stations. Notably mature *E. superba* females with eggs (**Fig. 9**) became abundant in our tows along the 200 line, especially at Station 200.000 where we conducted Process Study 2 (one tow was almost exclusively gravid *E. superba* females, which we do not recall happening in prior years). Krill were not as abundant at the mid-shelf stations; here copepods such as the large species *Rhincalanus gigas* were common.

In addition to our regular station operations, we conducted day and night sampling of zooplankton distribution at discrete depth intervals using the MOCNESS (Multiple Opening-Closing Net Environmental Sensing System) to investigate depth distribution and diel vertical migration of zooplankton at the both the inshore Marguerite Bay canyon station sand the slope process study station (**Fig. 10**).

We also conducted experiments at both the 200.000 and 200.180 Process Study stations. Meredith Nolan, a graduate student in Steinberg's lab, is conducting a series of experiments for her thesis on the effects of climate warming on the physiology of Antarctic zooplankton using heat shock proteins as an indicator of heat stress, taking samples along the PAL LTER grid and performing live incubations of animals at elevated temperature (**Fig. 11**).

Figure 9. Mature female *E. superba* krill with eggs surrounding, and compared to, a non-gravid individual (center). Photo by Debbie Steinberg.

Figure 10. Deploying the MOCNESS for a night tow. This tow fished to 500 m, and collected zooplankton in 8 discrete depth intervals. Photo by Debbie Steinberg.

Figure 11. Graduate student Meredith Nolan in the ship's aquarium room picking live animals for a heat shock protein experiment. Photo by Debbie Steinberg.

C-013: Seabird Component-LTER (Megan Cimino, PI; UC Santa Cruz and NOAA)

Field Team Members: Allie Northey (lead), Helena Dodge

The birder team has been deployed on Avian Island this week, and thus will provide an update in our next report. As you can see below (**Fig. 12**), this field camp requires a lot of preparation! This Adélie penguin colony is huge and can easily be seen (and smelled) from offshore (**Fig. 13**).

Figure 12. Allie Northey and Helena Dodge show off their field gear prior to loading the zodiacs that will take them to Avian Island to set up field camp. Photo by Debbie Steinberg.

Figure 13. Adélie penguins on Avian Island near the field camp site. Photo by Debbie Steinberg.

C-024: Cetacean Biology & Ecology (Ari Friedlaender, PI; UC Santa Cruz)

Field Team Members: Ross Nichols (lead), Dr. Jennifer Allen

This week, the Whalers continued their efforts to conduct bridge surveys of marine mammals. Sighting and surveys were conducted mostly during the scheduled Process Station. This week 15 humpback whales were sighted during bridge surveys, mostly performing travelling or surface feeding behaviors. On Jan. 13 we were able to deploy on a group of two humpback whales performing a mix of behaviors, a third humpback whale was also present travelling solo. During this deployment of the SOLAS boat, our group was able to collect dorsal fin (**Fig. 14**) and fluke images of 3 individuals, as well as 1 blubber and skin biopsy sample.

On Jan. 11, the whalers went ashore on Avian Island to collect an elephant seal skull which had been sighted for over 3 years on the island (**Fig. 15**). This animal died of unknown causes on the island, and had mostly decomposed, allowing for easy recovery of the skull without additional tissue removal. Our group was able to recover the entire skull, that had only minor damage. This included the skull and both lower jaw mandibles. The lower jaw of elephant seals is connected in the center by connective cartilage, and decomposes after death, leaving the lower jaw in two separate pieces. This sample will be stored frozen, and shipped to the Univeristy of CA, Santa Cruz for further analyses including isotopic analysis to determine the diet of the individual, as well as a morphological analysis used in a variety of applications.

Figure 14. Dorsal fin of a humpback whale. Dorsal fins can be used to identify humpback whales, and are especially useful while conducting operations, since this is the most visible part of the whale. Scarring and barnacle placement and density are used to differentiate individuals. Flukes are more useful for consistent matching of individuals, but are unobservable until the animal performs a dive.

Figure 15. The lower left mandible of an adult male elephant seal collected on Avian Island. This jawbone will be used for isotopic and morphometric analysis, upon delivery to U.C. Santa Cruz.