LMG 18-01: 05 Jan - 07 Feb. 2018 LTER Cruise 26
Weekly Science Report 4
29 January – 4 February, 2018

"Palmer Antarctica LTER (PAL): Land-Shelf-Ocean Connectivity, Ecosystem Resilience and Transformation in a Sea-Ice-Influenced Pelagic Ecosystem"

During the fourth week of LMG18-01 we accomplished several goals. Firstly, we sampled some inshore grid stations that have not been sampled in many years. These stations are inshore of the large islands of Adelaide, Lavoisier and Renaud, and represent and interesting comparison to our shelf and offshore stations as these inshore locations are heavily influenced by coastal inputs, e.g., glacial meltwater, nutrients, etc. Next, we were able to sample several bird locations and colonies (see below) that we are not able to sample every year and, in one case, has not been sampled in almost a decade (i.e., Hugo Island). For the final few days of the cruise, we are back in the Palmer Canyon area for our third process study, specfically to do some strategic resampling of the stations we sampled during the first process study.

Thanks to the skilled officers and crew under the command of Captain Ernest Stelly and ASC crew led by Lindsey Loughery for such efficient and excellent support.

Individual Team Components:

C-019: Phytoplankton Ecology (Oscar Schofield, PI, Rutgers University).

Field Team Members: Nicole Waite, Carly Moreno, Taylor Dodge, Steve Weber

The objective of this component of the Palmer LTER is to understand the physiological ecology and the spatial/temporal distribution of phytoplankton along the WAP. Field efforts are focused on three areas. The first is to maintain the core time series of the Palmer LTER. Core time series of the phytoplankton time series are chlorophyll a, HPLC to provide phytoplankton accessory pigments, chlorophyll *a* fluorescence induction measurements of photosynthetic quantum yields, and daily 14C-radioisotope uptake experiments. This year we are adding species identification to the time series through selected the addition of an automated imaging flow cytobot. We additionally characterize the bio-optical properties of the water column to provide optical baseline measurements for remote sensing approaches through the deployment of the profiling Bio-Spherical C-OPS spectral radiometer.

Additionally, during the cruise, we are also conducting manipulation experiments to assess factor driving the overall community composition within the LTER grid during process stations. This we are conducting deck-board incubations we are assessing the physiological signatures of iron limitation using fluorescence and RNA-based approaches in partnership with the laboratory of Professor Adrian Machetti at the University of North Carolina at Chapel Hill. We are also conducting experiments on selective grazing by phytoplankton species by Antarctic Peninsula in partnership with the Steinberg laboratory at the Virginia Institute of Marine Sciences and the laboratory of Professor Grace Saba at Rutgers University. The deck-board manipulations are being

conducted on the 01 deck of the Gould representing discrete short term incubations (12-24 hours). The water at the end of the incubations is being analyzed for fluorescence-based estimates of phytoplankton photo-physiology, HPLC pigments, chlorophyll, RNA-profiling and phytoplankton species composition.

Despite to less than ideal endings, both gliders were successfully recovered. We want to highlight that was the first year through the gliders we were able to link the field camps at Cape Sheriff and Rothera. This is exciting as it offers a glimpse of where gliders might be able to greatly extend the reach of field stations well beyond the boating limits. Both glider tracks were laid end to end, providing a regional snapshot of the WAP (**Figure 1**). The cooler water that had come Weddell is clearly visible while the remant winter water is clearly visible in the southern WAP. The second panel shows the chlorophyll flouroescence for those to same missions. On the land, red dots indicate (south to north) Rothera Station, Palmer Stations, Cape Sherriff, and Carlina Station on King George Island.

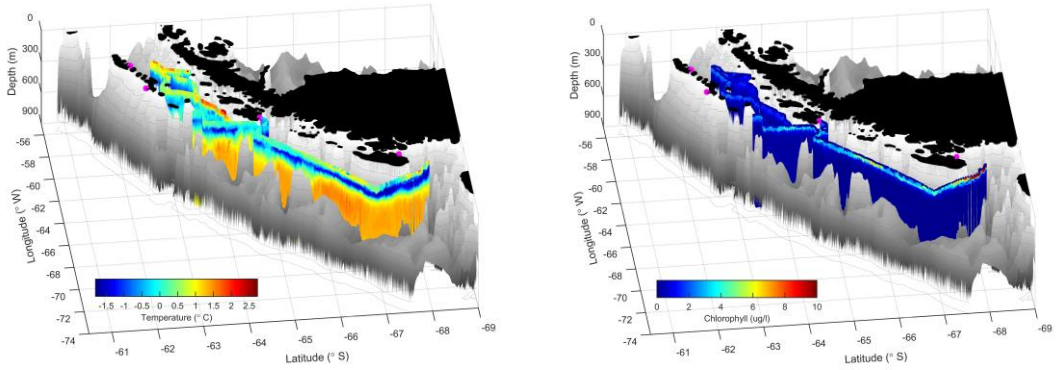

Figure 1. A regional snapshot of the temperature and chlorophyll from two gliders launched from Palmer Station during LTER 18-01.

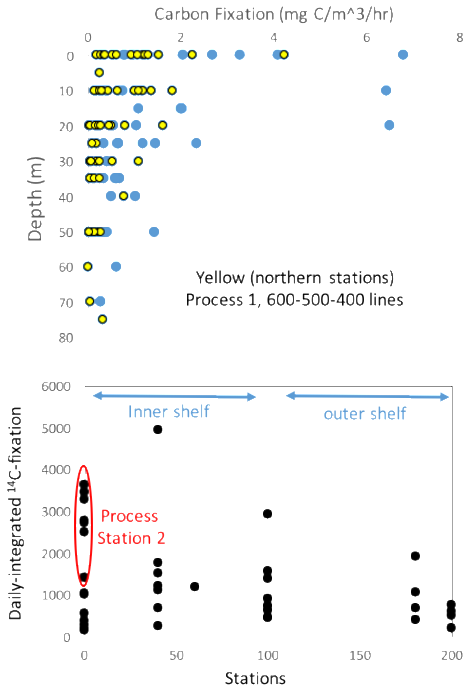

Figure. 2. A) Measured 14C uptake as a function of depth for the northern and southern stations occupied by LTER cruise 1801. B) Data sorted by station location.

The Gould sampling showed that the 14C-uptake measurements in the southern portion of the grid were significantly more productive than in the north (**Figure 2A**). In the northern half of the grid the hourly productivity rates only exceed 2 mg C m^{-3} h^{-1} twice, while there a significant number of stations in the south that had higher carbon fixation rates. Sorting by location on the shelf, it is clear that inner shelf was significantly more productive than the outer shelf (**Figure 2B**). With the exception of one station on the inner shelf, highest productivity rates were encountered during Process Study 2 in Marguerite Bay. The chlorophyll-normalized productivity never exceeded 2 this year, suggesting cells were not exceptionally healthy.

During recent sampling around Palmer deep we wanted to assess what (if any) deep ocean communication was between Palmer Deep and Gerlache Strait. Recent analysis of the LTER data suggests a significant amount of modified circumpolar deep water makes it to Palmer deep and plays a significant role in the heat budget there. We conducted a CTD survey and found no evidence the modified deep water in the Palmer Deep flows into the Gerlache.

C-013: Seabird Component (W.R. Fraser, PI)

Field Team Members: Darren Roberts and Megan Roberts

The final week of LTER 1801 was used to process samples collected on Avian Island, and the Fish Islands. This consisted of processing 31 diet samples, and preparing Adélie penguin toe nails for stable isotope analysis. In addition to processing lab samples, we conducted population assessment surveys at Armstrong Reef, the Fish Islands near Prospect Point, and Hugo Island. Diet samples were also collected at the Fish Islands.

Adélie Penguins, and Blue Eyed Shags were surveyed at Armstrong Reef (**Figure 3**) on January 28th. The last time Armstrong Reef was surveyed was in 2014. The population appears to have grown slightly since 2014, but with only two years of data available on the ship it is impossible to make any statement about the relative growth of the population.

Figure 3. Megan Roberts and Doug Nowacek surveying at Armstrong Reef.

Adélie Penguin surveys, and diet sampling was performed at the Fish Islands near Prospect Point on January 29th. The colony at the Fish Islands is slightly larger than last year, and has stayed on its past trajectory of stabile or growing. We retrieved 5 diet samples from adult Adélie Penguins (**Figure 4**). The majority of those diets consisted of *Euphausia superba.* One of the five diets consisted almost exclusively of juvenile *E. superba. Euphausia superba Euphausia crysylorophius*, and *Thysanoessa macrura* were all found in penguin diets this year. We found a large amount of fish tissue, including two skulls of what appear to be icefish. We did find Amphipods this year, but not in the same abundance as last year.

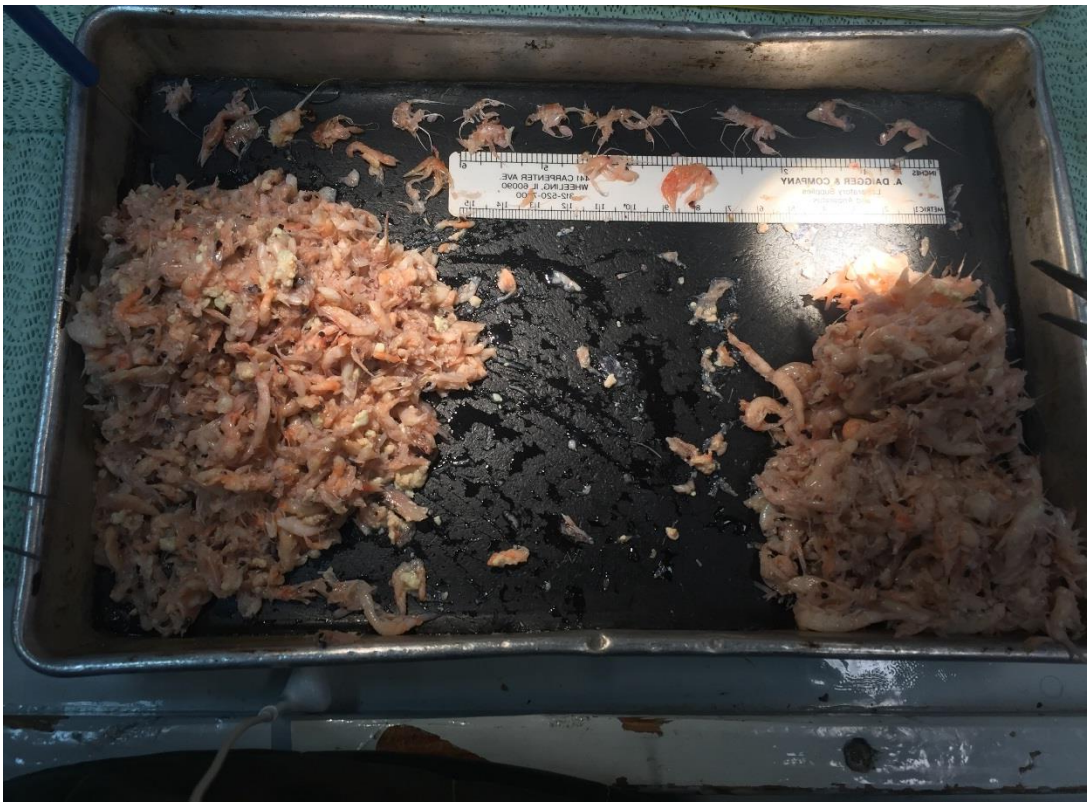

Figure 4. A selection of amphipods, and krill from a penguin diet.

Hugo Island (**Figure 5**) consists of one large island and several small islands. Gentoo, and Chinstrap Penguins have established colonies on three of these islands. We were able to survey all penguin colonies in the Hugo group. It has been nearly 10 years since our last visit to Hugo and much has changed. The Gentoo population has increased, and the Chinstrap colonies were documented officially for the first time. Hugo Island is now the home to the southernmost Chinstrap Penguin breeding colony on the WAP. We also observed three adult Macaroni Penguins.

Figure 5. A Gentoo Penguin colony at Hugo Island.

We would like to especially thank Captain Ernest Stelly, and mates Greg Goodwin, Ryan MacLellan, and Ben Gomez for safely navigating the Gould to and from all of our operations. Also, MTs Hannah Gray and Josh Mitchell deserve thanks for all of their around-the-clock zodiac support. We would like to sincerely thank all of the ASC staff. We especially thank Doug Nowacek, Lindsey Loughry, Oscar Schofield, Hugh Ducklow, Julian Dale, and Diane Hutt for going above and beyond in supporting the LTER mission.

C-020. Zooplankton Component (Debbie Steinberg, VIMS; PI)

Field Team Members: Joe Cope, Patricia Thibodeau, Andrew Corso, Kharis Schrage, and Colleen McBride.

During the fourth week, we sampled three inshore stations along a North/South gradient. As we moved northward, fauna transitioned from an ice-typical composition (copepods and gelatinous animals) to an ice-free composition, dominated by krill and other crustaceans. We conducted a northern offshore fecal pellet production rate experiment on *Euphausia superba.* We continued to collect animals for gut fluorescence and future physiological studies.

Tricia Thibodeau continuined to conduct experiments with the pteropod *Limacina helicina antarctica*. She conducted an experiment to monitor how *L. antarctica* metabolism changes under future CO2 conditions over 12 hours. *L. antarctica* ammonium excretion (as measured by Hollibaugh B-119) is not affected by increases in CO_2 (~800 ppm). These results indicate that *L. antarctica* metabolism is more strongly affected by short term changes in temperature and food, which did elicit a metabolic response, than in increases in CO_2.

While net tows might seem relatively simple and routine, a lot of effort goes into each one. Let's look in detail at a 2-m net tow (**Figure 6**). The tow actually starts with the ship operator on the bridge, who brings the ship up to towing speed, typically 2 – 2.5 knots. The ship operator maintains this speed throughout the tow, which is about a half hour long. A Marine Technician (MT) and a field team member on the back deck prepare the net for deployment. After everything is ready, a winch operator lifts the net from its stand and lowers it into the water. The winch operator lowers the net at 20 m/min to 120 meters depth, and then retrieves it at 15 m/min. The depth of the net is known at all times thanks to a depth meter, maintained by the Electronics Technicians (ET), on the end of the winch wire. Once at the surface, the net is guided back into its stand by the MT and field member. We wish to thank everyone involved with the tows, the ECO captain and crew of the *L.M. Gould* and the ASC MTs and ETs, for their expertise and help.

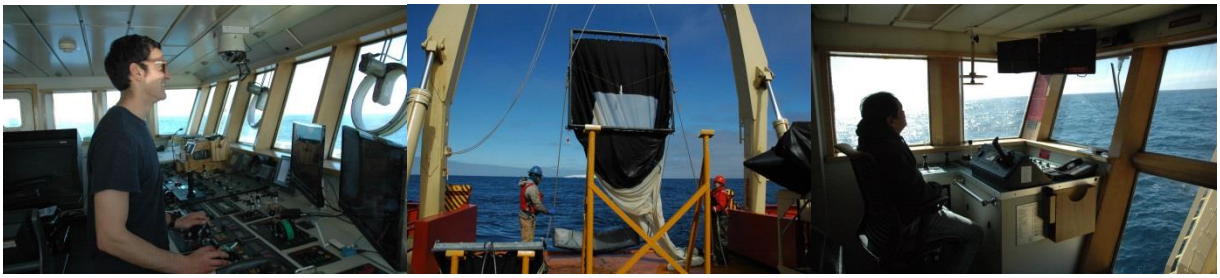

Figure 6. From left to right: ship operator on the bridge, net deployment by MT and field team member, and winch operator in the aft control center.

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

Field Team Members: Doug Nowacek (Co-PI) and Julian Dale, Duke University.

Week 4 was relatively quiet for the whale ecology component of the program, due primarily to two factors. First was the weather, which has continued to be unworkable for our operations a significant percentage of the time. Next, late in week 3 one of the whale team, Julian Dale had to leave the cruise unexpectedly and return home due to a family medical situation. Julian was the UAS pilot for the team, so this component of our sampling had to be discontinued. During week 4, however, we did conduct several surveys and sampling periods, with the help of the birder team, Darren Roberts and Megan Roberts, who very capably assisted with data collection in Julian's absence. During our trip north from the Marguerite Bay/Adelaide Island area we surveyed through

Crystal Sound, the Fish Islands, and then the southern Argentine Islands before the ship moved offshore to survey Hugo Island for birds and then on to the sediment trap recovery. During these inshore surveys, we successfully collected eight photo-identification (**Figure 7**) / biopsy samples from humpback whales. These waters are relatively underrepresented in our overall LTER photo-id and biopsy records, so these were important samples to collect.

Figure 7. Tail flukes of a humpback whale photographed along the WAP. The distinctive patterns and coloration on the ventral side of the flukes are individually distinctive and allow us to identify individual whales from year to year. These photos are also contributed to a worldwide catalog and matches can be made if the whale is photographed in other locations.

C-045: Microbial Biogeochemistry Component (H. Ducklow, Lamont Doherty Earth Observatory; PI).

Field Team Members: Hugh Ducklow, Naomi Shelton, Rebecca Trinh, Hugo Berthelot, Mar Arroyo and Shana Leshko

The highlight of our week was recovery, turnaround and deployment of our sediment trap (**Figure 8**). Trap operations were accomplished safely and securely this year in high seas. Recovery and most of the turnaround were completed on Feb. 1, but final redeployment was postponed until Feb 3 due to high winds and seas. Thanks to many ship and ASC support personnel who made this possible, notably MT Hannah Gray, who organized and oversaw deck operations. Initial examination (**Figure 9**) of trap contents suggests a high flux event in Feb-March.

Figure 8. Recovery of the McLane sediment trap on 1 February.

Figure 9. Sediment trap cups from 2017-18 deployment. Cups L to R: 2/4/17 to 2/3/18. Personnel L to R: Mar Arroyo, M. Arroyo, M. Arroyo. Photos: Rebecca Trinh.

Project B114: Chemoautotrophy in Antarctic Waters (J. Hollibaugh, University of Georgia; PI) aboard LMG 18-01

Project Researchers: James T, Hollibaugh and Brian N. Popp

Sampling collection for nitrification rate measurement is proceeding smoothly. Measurements have been initiated for a total of 102 samples using ^{15}N-labeled nitrite, ammonium and urea, with a subset (39 samples) analyzed for oxidation of ^{15}N from putrescine. Ninety seven measurements have been completed to date, with the remainder (methods verification experiments performed with water collected at grid station 600.180 on 31 January) currently in the incubator. We anticipate initiating 2 or 3 more experiments during Process Study 3 scheduled for stations around Palmer Deep on the weekend.

We have also measured nitrite and ammonium concentrations in the same samples (these are consistently <100 nM). Samples for determining nitrification rate have been frozen at -80 ^{0}C awaiting del^{15}N determination in Popp's lab at the University of Hawaii. The success of our sampling effort has necessitated requesting permission to ship an additional box (4 total) of -80 C samples to Popp's laboratory.

We have collected particulate DNA from this same set of samples. These samples, which are in Sterivex filter capsules, have been fixed with lysis buffer and frozen at -80 ^{o}C pending analysis in my lab at UGA after the cruise ends.

Chemoautotrophy measurements (incorporation of $NaH^{14}CO_3$ in darkness) have been run on 36 samples, including 4 sets of verification studies. These have all been counted. Preliminary analyses indicate very low chemoautotrophic potentials for these waters: mean values of 56 and

27 mg C m^{-3} d^{-1} in the Winter Water (50-100 m depth range) the circumpolar deep water (>200 m), respectively. Rates in deep-water (>2500 m) samples from stations over the shelf-break and slope at the seaward ends of grid lines are <2 mg C m^{-3} d^{-1}.

We have not encountered any insurmountable issues in our program, other than those related to weather. We are running out of supplies; however, and will only be able to complete the verification studies mentioned above before the end of the cruise next week.