LMG 16-01: 03 Jan -- 17 Feb. 2016 LTER Cruise 24
Final Weekly Science Report
01 – 11 February, 2016

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

Operations over the past ten days continued to be affected by the shifting, sometimes heavy sea ice cover. The week started with successful recovery and deployment of the long-term sediment trap near Hugo Island, in the northern, midshelf region of our study area, about 60 miles from Palmer Station (see the 045 report below). We deployed a physical oceanography mooring in loose 8/10 ice at station 300.040, but two planned deployments at stations 300.060 and 300.100 had to be scrubbed due to heavy ice cover and the presence of several large bergs (**Figure 1**). We completed our third process study comparing areas near Palmer Station with and without whales. Finally, we took on board the birder team from Palmer Station (Bill Fraser, Shawn Farry and Ben Cook) who teamed with our birders to conduct a census of Adelie, Chinstrap and Gentoo populations in the Rosenthal Islands, on the NW side of Anvers Island.

Figure 1. 10/10 sea ice cover and big bergs at station 300.060, Feb. 5, 2016

The highly anomalous ice conditions forced us to slow down transits between stations and prevented us from occupying stations south of the 200 line plus a few others. As a result we have fewer samples than usual, but on the other hand everything we did collect has extra value in this extraordinary year.

Thanks to MPC Lindsey Loughery and her great science support staff. MLT Kate Ruck (an LTER alumnus) kept all the science groups running smoothly, safely and cleanly. Thanks to MTs Carmen Greto and Jack Greenberg for their skilled supervision of many deck ops including several difficult mooring operations in the ice. ETs Alec Chin and Julian Race turned around mooring hardware, kept us in touch with the outside world and kept data streams flowing.

Thanks also to Bob Farrell, NSF-Antarctic Sciences and ASC Marine for facilitating the personnel swap with Palmer Station, enabling the combined birder groups to perform their survey. Finally, thanks to Captain Ernest Stelly and his officers and crew for an amazing job of driving our vessel through the ice. A special callout to Chef Lorenzo Sandoval and his staff for outstanding food! It's the first time I gained weight on an LTER cruise.

Individual component reports:

C-013: Seabird Component (W.R. Fraser, PI)
Field Team Members: Carrie McAtee and Darren Roberts

Our final week of LTER16 consisted of additional at-sea observations of seabirds near the 300 grid-line and Palmer Deep area, in addition to an off-ship excursion to colonies of breeding Adélie penguins in proximity to Prospect Point and the Fish Islands. Our fieldwork at the Fish Islands included diet sampling (**Fig. 2**) adult Adélie penguins and conducting censuses of 8 individual islands. In the final few days of the cruise we plan to visit the Rosenthal Islands for similar field work with Chinstrap and Gentoo Penguins.

Figure 2. Stomach contents of an Adélie penguin; Semi-fresh *Euphausia Superba* krill and large fish chunks. Tiny fish ear bones, known as otoliths are collected and put into wells within trays like the one seen in the lower right corner of this photo. These can be used to ID the species of fish penguins are foraging for. Some diet samples contain over 50 otoliths.

We would like to especially thank Captain Enrest Stelly, and mates Zsolt Esztergomi, Ladd Olsen and Rob Depietri for navigating the Gould to and from all of our operations. Also, MTs Carmen Greto and Jack Greenberg deserve thanks for all of their around-the-clock zodiac support. Special thanks MPC Lindsey Loughry, who have provided incalculable support for the C-013 birders throughout the entirety of the cruise.

C-019: Phytoplankton Component (O. Schofield, Rutgers; PI)
Field Team Members: Nicole Couto, Carly Moreno, Shungudzemwoyo Garaba, Kayla Evens, Emily Olson

As we wrap up the cruise, we'll wrap up the introductions of our team members. Amber Annett is a postdoctoral research associate at Rutgers University. Her background is in Antarctic biogeochemistry and trace metals, and she spent three seasons working at the British Antarctic Survey Rothera Research Station as part of her graduate studies through the University of Edinburgh. She also spent a full year working at Rothera Station as a marine research assistant, collecting water samples and CTD data during the Antarctic winter. She has been an invaluable help to the trace metal team on this cruise with their ambitious sampling plan (**Fig. 3**).

Figure 3. Mike Brown, Amber Annett, and Jess Fitzsimmons sampling a glacial melt water stream for trace metals at Palmer Station during the January port call.

Trends throughout the cruise have shown happy, healthy phytoplankton in the coastal areas. Fluorescence induction relaxation measurements (Fv/Fm) are higher in the inshore and midshelf regions of the grid, indicating that phytoplankton in these areas are healthier and have more access to nutrients than those offshore (**Fig. 4**). Fv/Fm values above 0.5 suggest that

phytoplankton are particularly stress-free and we have seen plenty of values at least this high on the cruise. Similarly, rates of primary production are higher at the inshore stations compared to the offshore stations (**Fig. 5**).

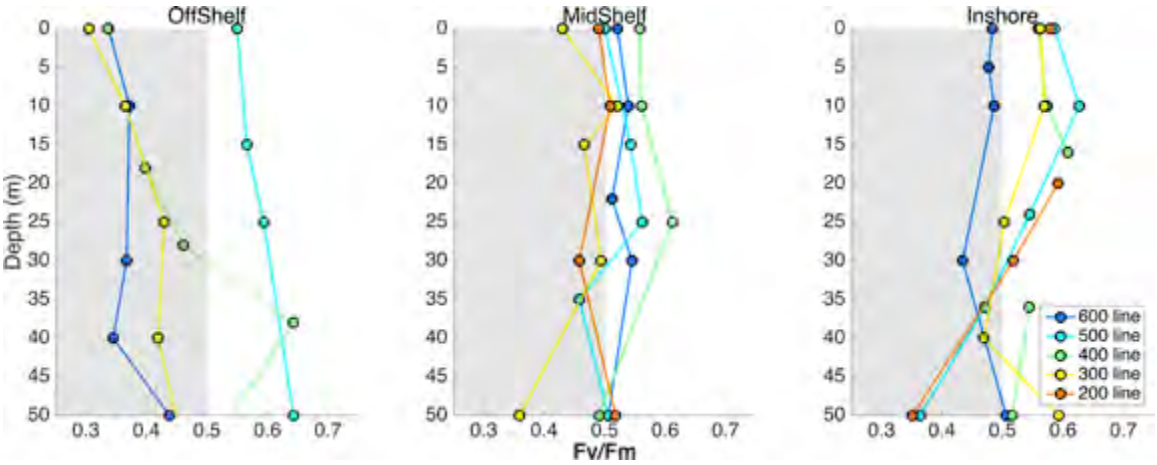

Figure 4. Fv/Fm values for all full stations on the LTER grid.

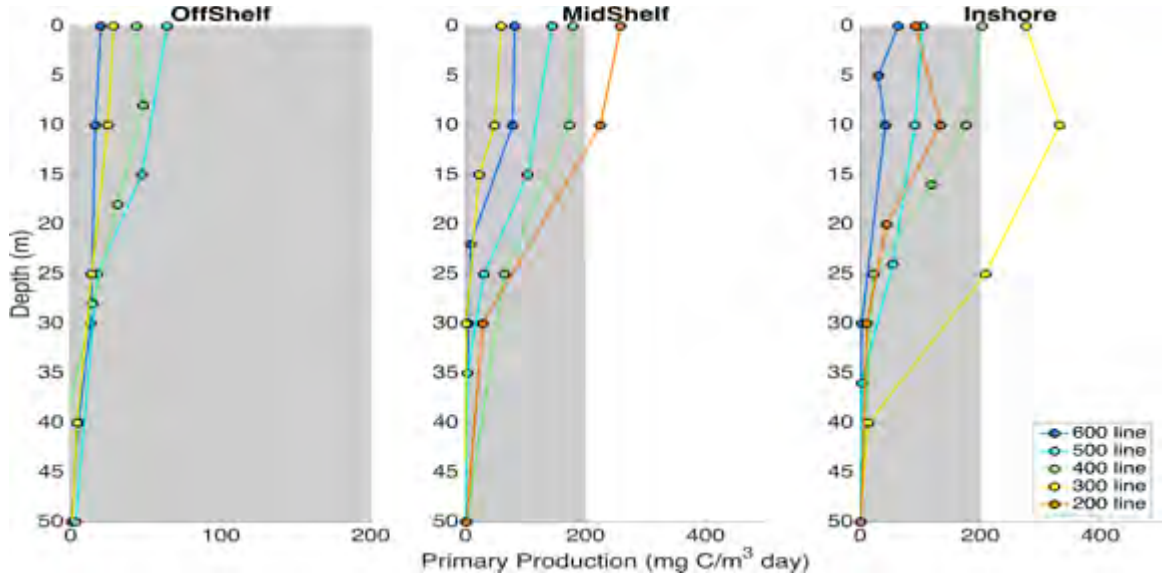

Figure 5. Rates of primary production for all full stations on the LTER grid.

On Feb. 9th, we successfully recovered a mooring from Station E, near Palmer Station that Nicole deployed from the LMG in early November (**Fig. 6**) and has since been measuring bottom temperature and current velocities throughout the water column. Nicole will be analyzing this data as part of her PhD research on ocean currents and heat transport to the near-shore regions of the west Antarctic Peninsula.

That's all from the Schofield group. Thanks to the captain and crew of the Laurence M. Gould for a great cruise!

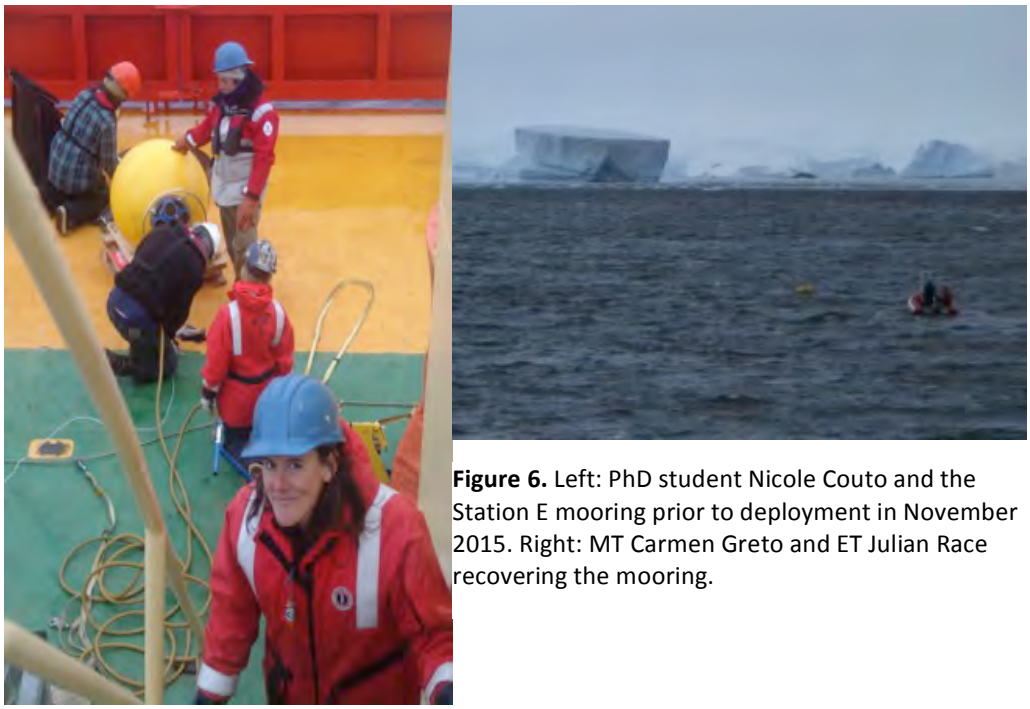

Figure 6. Left: PhD student Nicole Couto and the Station E mooring prior to deployment in November 2015. Right: MT Carmen Greto and ET Julian Race recovering the mooring.

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

Field Team Members: Joe Cope, Patricia Thibodeau, Anjali Bhatnagar, Andrew Corso, and Danielle Hall.

During the final week, we completed our third Process Study. The study contrasted areas with and without whales near the Palmer deep. Adult krill, *Euphausia superba* and *Thysanoessa*, were abundant at both areas, although less so at the whale site. Arrow worms and copepods were also abundant. We continued to collect animals for gut fluorescence, mercury contamination, and the VIMS Invertebrate Collection.

We collect zooplankton with three different nets: the 1-m and 2-m Metro nets, and the MOCNESS. Although the net tows require ship time and several people to deploy, the real work begins after the sample is on board (**Fig. 7**). The animals captured by the net are washed into a small bucket, or cod end, at the end of the net. The contents of cod end are then gently poured into a tub. Large or delicate animals, such as jelly fish, are removed from the tub so that the animals are not damaged and that further processing is simpler. Predators, such as the amphipod *Themisto*, are also removed before they eat the prey animals that we are trying to count. We then bring a manageable portion of the sample into the laboratory. Each individual is separated by

taxon and counted. After the whole sample has been processed, the number of individuals and volume of each taxon is recorded. While a net tow usually takes less than an hour, processing the animals can take 2 to 4 hours.

Figure 7. Clockwise from top left: Graduate student Danielle Hall removes predators from the sample. Undergraduate students Anjali Bhatnagar and Andrew Corso sort taxa in the laboratory. A processed sample with the various taxa separated.

C-024: Cetacean Biology & Ecology (A. Friedlaender, Oregon State University, PI).

Field Team Members: Erin Pickett, Oregon State University.
At Palmer Station: Doug Nowacek (Co-PI) & Logan Pallin.

During the 4th week of the LTER cruise, we continued to survey the seascape commensurate with the final stages of the sampling stations on the grid. During the process station study south of Avian Island, we had generally good conditions in and around the margins of the pack ice. We saw no whales during this period or the rest of the time in and around Marguerite Bay. This is a surprising result that we will continue to ponder. Moving north and inshore from the Bismark Strait to Prospect Point, we surveyed under exceptional sighting conditions and once again sighted no whales although we encountered several large and dense krill patches on the echosounders. The lack of whales in both of these areas agrees with the distribution and movement of the whales that we tagged early in the study period. These whales, as seen below,

have largely remained in the continental shelf waters south of Anvers Island, with one animal moving north through the Gerlache Strait and associated bays. This distribution and movement agrees with previous years during this month when krill are thought to be broadly distributed over the shelf waters before moving inshore towards fall.

We have now collected 37 skin and blubber biopsy samples and over 30 individually identifiable fluke photographs that will contribute to our demographic studies to determine the sex ratios, stock structure, and pregnancy rates of this feeding population. Below is a photograph showing a biopsy sample being collected and an individually identifiable fluke photograph (**Fig. 8**).

Figure 8. humpback whale flukes (top) showing unique marking patterns and humpback whale dorsal fin (bottom) with a biopsy dart present in flight to collect a small skin and blubber sample.

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

Field Team Members: Hugh Ducklow, Naomi Shelton, Ribanna Dittrich, Emilie Schattman and Griffin Whitlock.

We continued to collect core LTER samples (bacterial abundance and activity, dissolved inorganic and organic carbon, particulate organic carbon, particulate nitrogen, Oxygen-18, dissolved macronutrients). The bacterial leucine incorporation rate assays at the Process 3 study

site provide additional areal and temporal coverage of the Palmer Deep region and largely bear out the preliminary conclusions suggested in last week's report: bacterial production rates are slightly higher than in the previous few years, except for the monster year of 2014. Bacterial abundance results await analysis at home, due to the unfortunate breakdown of our flow cytometer.

Figure 9. Clockwise from upper left: recovery of sediment trap. Water is draining from the collecting funnel. Upper right: deploying yellow hard hat floats for the trap mooring. Bottom: C045 team from left: Griff, Riba, Joe the Trap, Naomi, Emilie, Hugh. Photo credits: Naomi Shelton.

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The highlight of our week was successful recovery and deployment of the long term (1992-present) sediment trap (**Fig. 9**) at LTER Grid reference ~580.130, in the northern midshelf region of our study area, in 350 meters bottom depth. The trap is moored at 170 meters in the water column, in an attempt to sample the flux of particles sinking out of the surface layer while minimizing the entry into the trap, and subsequent death of zooplankton "swimmers" – actively swimming animals that enter the trap and are poisoned by the formaldehyde preservative, rather than being part of the constellation of passively sinking particles. Often, this wish goes unfulfilled, as the trap seems to operate more like a water hole in the desert, or a dumpster attracting rats, than simply a sinking particle interceptor (**Fig 10, left**). The particle flux varies by

Figure 10. Left: Dissecting micrscope photo of swimmers in a sediment trap sample. K: Antarctic krill; C: copepods; O: ostracod; F: krill fecal pellet; P: polychaete worm. Right: trap collection cups showing higher (cups 3-5, Feb 15 - May 01) and lower fluxes (cups 19-21, Jan 10-31). Photo credits: Naomi Shelton (left), Hugh Ducklow (right)

over an order of magnitude during the year, as illustrated by simple examination of the collection cups following recovery (**Fig. 10, right**).

B-203: Trace Metals (Rob Sherrell, Rutgers University, PI).

Field Team Members: Jessica Fitzsimmons and Laramie Jensen (Texas A&M University)

The trace metals group finished all sampling this week, with profiles and +/- iron addition incubations complete at every station visited on the 600 to the 200 lines, as well as at all process study stations. A highlight this week was sampling in the Penola Strait next to a large glacier, which will allow us to constrain glacial iron inputs to the WAP continental shelf. We also were able to collect high-resolution surface seawater samples with the trace metal towfish across the shelf-break of the 600 line, where we hypothesize that increased turbulence may cause increased transport of metals to the surface.

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Our major effort this week was setting up a large incubation experiment that has been a dream of field team member Fitzsimmons's since her PhD. This experiment tested the relative bioavailability of small soluble iron species (< 3 nm in size), colloidal iron species (3 nm – 200 nm in size), and particulate iron species (>200 nm in size). It required the collection of cells that are iron-starved in order to solicit a response to natural iron additions. For this purpose, we occupied offshore station 600.260, where we found the anemic cells that we were looking for. This incubation experiment is still being processed, but early results suggest that the larger colloidal and particulate iron species did not confer significantly greater cell growth or cellular health than the smallest and thus most bioavailable soluble iron species. Experiments such as these are rare in the literature but extremely important in order to place our growing understanding of iron physicochemical speciation and distribution into the context of the effect of these species on the whole ecosystem.

Overall, the trace metal group had an extremely successful expedition (**Figure 11**). The majority of results await further work in the Sherrell lab at Rutgers University, but all indications suggest that this will be a high-quality data set that will offer a great contrast to last year's results with respect to sea ice concentrations, as well as a closer look at certain trace metal sources (especially glaciers and sediments). We offer many thanks to the cooperative work of the entire LTER group, and the ASC and ECO personnel who have helped us accomplish everything we set out to do. It's been a great cruise!

Figure 11. The trace metal team in aft control on the last trace metal CTD cast of LTER 2016 (Jessica Fitzsimmons second from left and Laramie Jensen in front center, Texas A&M). Many thanks to the ASC team (Alec Chin pictured at left) and frequent LTER team help