LMG 16-01: 03 Jan -- 17 Feb. 2016 LTER Cruise 24
Weekly Science Report 2
17-23 January, 2016

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

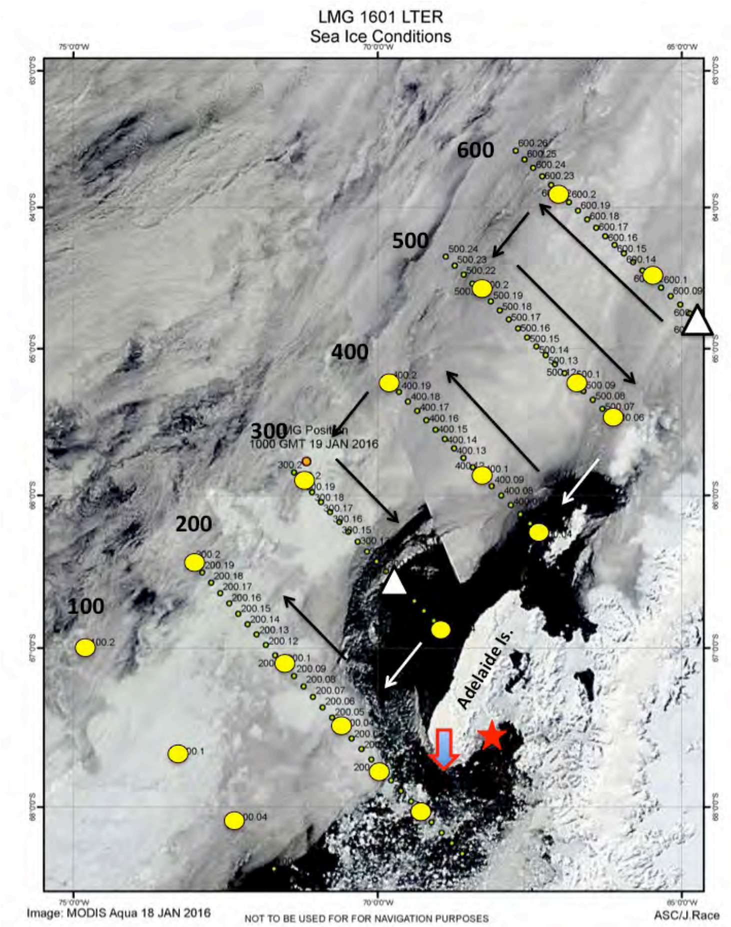

Figure 1. MODIS Terra sea ice image showing western Antarctic Peninsula region, PAL hydrographic stations (yellow circles) and cruise survey region. Black areas are open water. Black arrows show direction of travel. Triangles: physical oceanography moorings. Star: Rothera Base. Red arrow: Avian Island. Image constructed by ET Julian Race.

The big story this week continues to be the sea ice (Figure 1). Most of our study area is covered by ice, lowering our transit speeds to 5 knots and less. This is unprecedented, at least in the past 15 years of LTER cruises. Even so, we have managed to occupy all our intended hydrographic stations on the 600, 500, 400, 300 and 200 lines of the PAL survey grid. We successfully recovered one physical oceanography mooring, but had to leave three others in the water, because of the ice cover. We will revisit the mooring sites later in the cruise. After finshing the 200 line, we will visit the British Rothera Base (see map) on Saturday-Sunday. Our annual visit is part of a formal collaboration beween Palmer LTER and the British Antarctic Survey's Rothera Time Series Program. After leaving Rothera on Sunday morning, we will deploy the seabird team onto Avian Island (see map) for five days, and then commence our second Process Study in the Avian Island penguin foraging region.

Thanks to the skilled officers and crew under the command of Captain Ernest Stelly, for taking us into, around, through and out of the ice as our science demands. Special thanks to the ship's mates, Zsolt Esztergomi, Ladd Olsen and Rob Depietri for patient and smooth driving through the ice.

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Individual component reports:

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

In the last week, we continued visual surveys from the bridge along the 500,400,300 and 200 lines between underway sampling points as well as at full stations. The shelf break regions of all grid lines have continued to be productive areas for our surveys. Interestingly, however, the coastal stations have yet to provide the abundance we've seen in past years and diversity has been quite low in these areas. Snow Petrels, Adelie Penguins, Crab-eater Seals, and Wilson's Storm Petrels were the most abundant species sighted this week. We have yet to observe large groups of the usual suspects of Cape Petrels or Southern Fulmars following the ship. Prion sp. and Albatross sp. have also been scarce. There were two separate sightings of single Emperor Penguins on ice floes this week.

Figure 2. A Leopard seal sleeps near 200.120 unaware of a crack forming in the ice as the Gould pushes through thick ice flows.

We're counting on amenable sea ice conditions near the southern end of Adelaide Island to allow us to access Avian Island; the land of close to 100,000 Adelie Penguins and hundreds of Elephant Seals. We've begun our preparations for our departure and plan to camp from January 24th-29th.

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

As the cruise progresses, C-019 continues to measure optical properties of the ocean. A platform on the ship's bow and mast is collecting radiometric quantities underway, creating an invaluable dataset of various ocean surface and meteorological conditions. At each station, depending on ocean state, the optical cage is deployed twice: once to obtain background optical properties and again to obtain *in situ* inherent optical properties up to 150 m water depth (**Fig. 3**). Water clarity is measured using a classic tool, the Secchi disk, depending on ocean conditions.

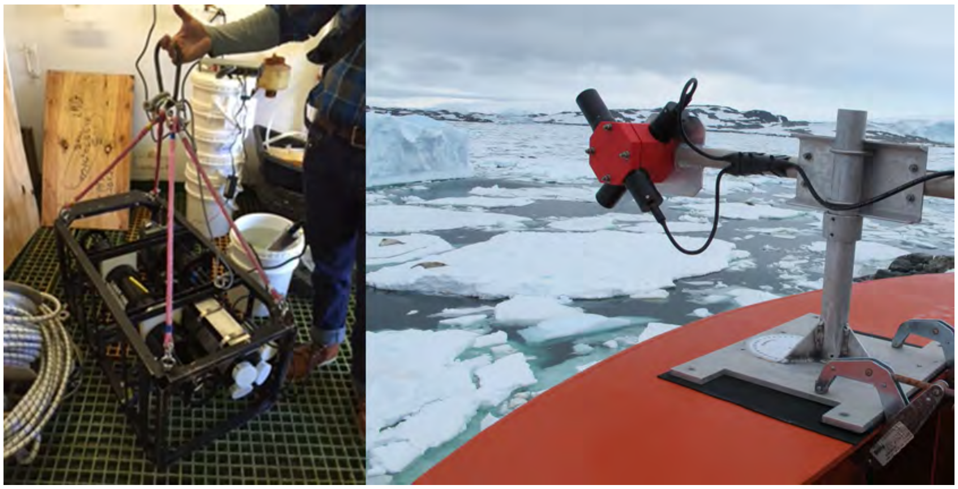

Figure 3. Optical cage (left) and shipborne radiometer (right)

For her dissertation at UNC Chapel Hill, Carly Moreno is studying the molecular mechanisms of how natural eurkaryotic plankton assemblages, particularly diatoms, respond to iron and light limitation by leveraging high-throughput sequencing technology. She uses metatranscriptomics, or the expressed genes of the community, to identify changes in gene expression associated with iron and light limitation. These abiotic factors have been shown to be limiting at different times and regions of the WAP. Carly will be collecting underway samples to capture snapshots of the plankton community and their expression patterns along the grid. She will also be performing six incubation experiments in two canyon regions and along an onshore to offshore gradient along the grid. She is collecting water at nearly all of the underway stations and has finished two three-day incubation experiments from 600.200 and 300.200.

As part of a collaboration with Dr. Nicolas Cassar at Duke University, Carly is also running the Equilibrator Inlet Mass Spectrometer (EIMS) to measure net community productivity (NCP) . It measures oxygen, argon, nitrogen, and carbon dioxide along our cruisetrack. The ratio of O_2/Ar reflects the NCP and carbon export in the mixed layer at steady state. Naomi Shelton (C-045) and Carly installed the quadrupole mass spectrometer and after some lengthy troubleshooting, it has been running continuously. A companion EIMS at Palmer Station operated by C-045 is collecting continuous O2/Ar data from the seawater intake, forming a high-resolution temporal dataset to compliment the high-res spatial data collected on LMG.

Throughout the cruise, the phytoplankton team will continue the time series of chlorophyll, pigment concentration, primary productivity and fluorescent yield measurements at all the major LTER grid stations and in the process study stations. At the Palmer Deep process study this year, we found that rates of primary production were higher on the northern flank of the canyon than the southern, and by far were highest at the head of the canyon, which is consistent with a central hypothesis of LTER that canyon-induced upwelling promotes production (**Fig. 2**).

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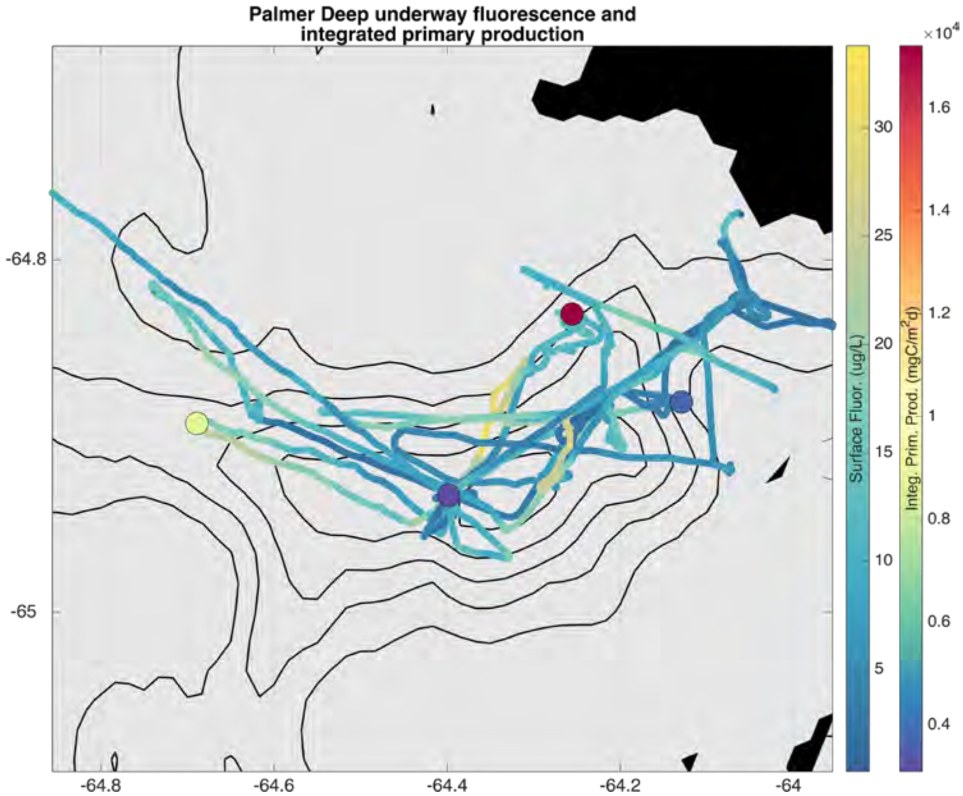

Figure 4. Underway surface chlorophyll fluorescence and integrated primary production in Palmer Deep.

Primary productivity is showing a decreasing trend from the inshore stations to the offshelf stations (**Fig. 5**). Similarly, biogenic oxygen, as shown by the ratio O2/Ar, decreases from onshore to off the shelf (**Fig 6**).

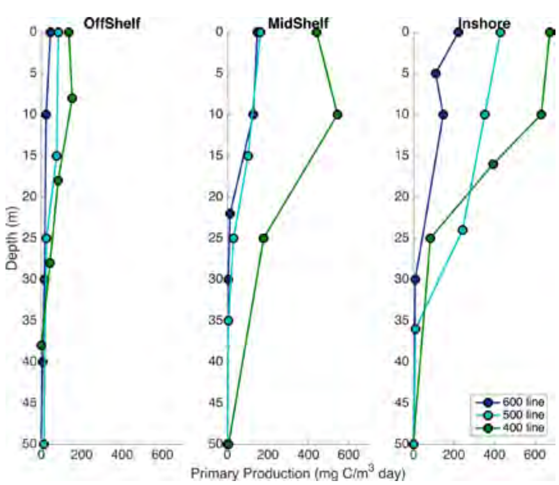

Figure 5. Rates of primary production on the 600, 500, and 400 lines

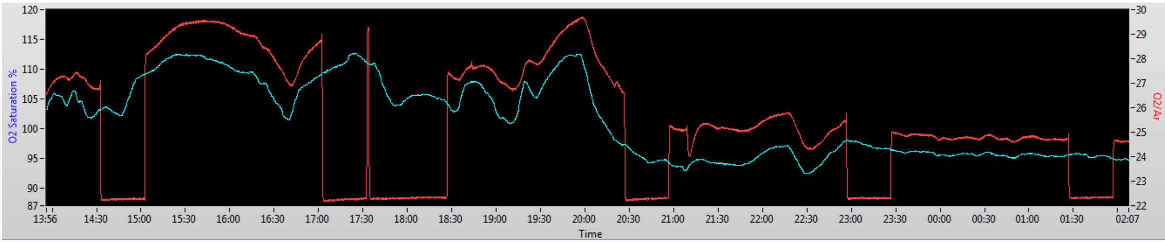

Figure 6. O2/Ar moving from onshore to offshore 300.060 to 300.200

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

Field Team Members: Joe Cope, Patricia Thibodeau, Anjali Bhatnagar, Andrew Corso, and Danielle Hall (Fig. 5).

During the second week, we deployed our 1- and 2-m nets along the 400, 300, and 200 grid lines. The nets appear to be holding up to the ice, although we did have to patch a few small holes. The salp blooms at the outer stations that we reported last year were not present this year, likely due to the heavy ice we encountered. However, the high abundances of copepods at the inshore stations on the 200 line were seen again this year. Juvenile *Euphausia superba* and *E. crystallorophias* were common in the coastal waters. Aside from a few juveniles, Antarctic silverfish, *Pleurogramma*, larvae were conspicuously absent. We conducted an offshore fecal pellet production rate experiment on *E. superba* collected at 500.200 for comparison with our onshore experiments. We continued to collect animals for gut fluorescence, mercury contamination, and the VIMS Invertebrate Collection.

As part of her dissertation research, VIMS graduate student, Tricia Thibodeau (**Fig. 7**), began conducting preliminary experiments on the Antarctic pteropod (pelagic snail) *Limacina helicina antarctica*. She is interested in understanding the effects of global change (e.g., warming and ocean acidification) on the physiology of these unique gastropods. As part of this work, Tricia has been dissecting *L. helicina* guts in order to conduct molecular studies back at VIMS to determine what they are eating. She also conducted a fecal pellet experiment to determine the shape of the *L. helicina* fecal pellets and their carbon content.

Figure 7. Left: *Limacina helicina antarctica* after completing the fecal pellet experiment. Right: Tricia Thibodeau conducting a fecal pellet experiment.

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 second week of operations as we began the LTER survey grid whale operations shifted gears to more of a visual survey mode. We have encountered significant areas of heavy pack ice south and west of Anvers Island and as we continued to the south. We have had very few whale sightings despite good conditions. The lack of whales in the sea ice is not surprising; however, we sighted no whales during a fine day transiting between the 500 and 400 line off the west side of Renaud Island and the Matha Strait. Later in the season, this area has traditionally been an active feeding ground for humpback whales. The lack of whales to the south is further supported by the locations and movement of our satellite tagged whales. Figure 8 shows positions for 5 of our tagged whales during their first week in relation to the broad-scale distribution of sea ice in the region. The whales appear to be focusing their movements around the Palmer Deep Canyon and the south side of Anvers Island.

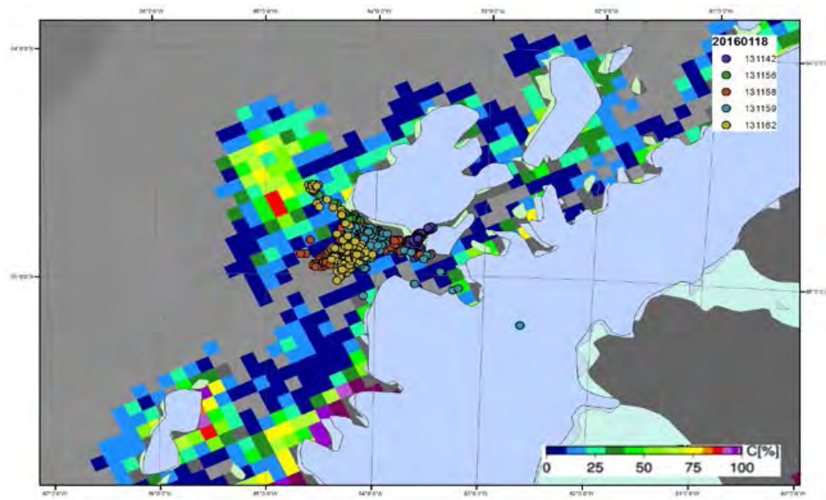

Figure 8. Satellite-derived positions (dots) for five humpback whales outfitted with transmitting tags. Each whale's locations are coded in different colors (see 20160118 Legend). The movement of the whales is shown in relation to the broad-scale distribution and % cover of sea ice (colored squares). Whales are focusing their movements in the Palmer Deep Canyon and near the inshore edge of the sea ice to the west of Anvers Island, but generally do not move in heavy pack ice.

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 sample along the 600 to 200 survey lines. Bacterial production rates have generally been low, possibly indicating that the bacterial community has not started to respond to the extensive accumulations of sea ice algae in the unusual summer sea ice.

Figure 9. C-045 team member Riba Dittrich aboard Zodiac Bruiser at Palmer Station E. Photo Credit:

This week we feature Ribanna (Riba) Dittrich (**Fig. 9**), our cruise team member from the University of Edinburgh where she is working toward her PhD under the direction of Prof. Sian Henly. Sian has worked at Rothera and collaborating with us, under the auspices of our formal collaboration with BAS. Besides conducting our Thorium-234 analyses, Riba is investigating the importance of dissolved organic matter (DOM) in the West Antarctic Peninsula region. DOM is produced by microorganisms released to the surrounding water. Here, it either becomes incorporated in the microbial loop and recycled or it is transported out of the euphotic zone to the deep ocean where it may be stored for thousands of years. Compared to lower-latitude ecosystems, only little DOM is produced along the WAP and even less is utilized by bacteria. The distribution and isotopic composition of dissolved organic nitrogen (DON) compounds along the Palmer LTER grid, and comparison to the PAL time series of dissolved organic carbon (DOC) data, will help Riba to understand mechanisms and processes that affect DOM production, transformation and loss, and possible effects of climate warming on these biogeochemical cycles.

B-203: Trace Metals (Rob Sherrell, Rutgers University, PI).
Field Team Members: Jessica Fitzsimmons and Laramie Jensen (Texas A&M University)

The trace metals program has been largely successful in Week Two, thanks to full incorporation into the LTER sampling plan and continued support from the captain, crew, and ASC staff. Trace metal CTD operations are going extremely well. The decision not to add additional weight to the CTD has been acceptable even in the heavy seas we experienced this week, and any issues that have arisen with equipment or sensor performance have been resolved immediately by the very supportive ASC staff. We have successfully collected vertical profiles for all of our dissolved and particulate sample types at every planned station on the 600, 500, 400, and 300 lines. This includes two deep casts at 500.200 and 300.200, which were a significant improvement over last year when we were not able to sample any deep stations because of problems with the COM10 winch. These deeper samples will allow us to place our measured trace metal concentrations on the WAP continental shelf into the larger context of the Southern Ocean in order to assess the significance of off-shelf metal transport on Southern Ocean metal distributions and primary production. We are very satisfied with the stellar performance of the trace metal CTD/rosette (**Fig. 10**) that we have enjoyed to date.

In addition to profiling CTD work, we aimed to take surface samples using the trace metal towfish every 20km along all of the LTER grid lines. This surface sampling would provide high-resolution trace metal concentration maps that we could compare with results from our similar efforts in 2010, 2011, 2012, and 2015. In Week One, we were not able to deploy the trace metal towfish very much because of heavy ice near Palmer Station, and we have continued to be hampered by heavy ice in our surface sampling efforts through much of Week Two. We were able to deploy the towfish successfully during transit between the 600 and 500 lines, and during that time we set up a large incubation experiment to test the relative bioavailability of various physicochemical pools of Fe from Palmer Station to offshore, Fe-starved phytoplankton communities. We also used the towfish to help PhD student Carly Moreno (of the Schofield group) set up incubations testing the transcriptomic response of phytoplankton to various treatments of Fe and light at two locations on the northern LTER grid.

However, during sampling with the trace metal towfish on the 300 line, a forceful event (likely collision with ice, though we don't know for sure) caused the main line tying off the towfish to the ship to shear, which resulted in a rapid extension of the towfish into the ocean and some damage to the pump and plumbing. Fortunately, no equipment was lost because the safety line securing the equipment held strong, and no one was hurt in this event. We thank the ASC staff for their incredible support in helping us get our equipment back up and running.

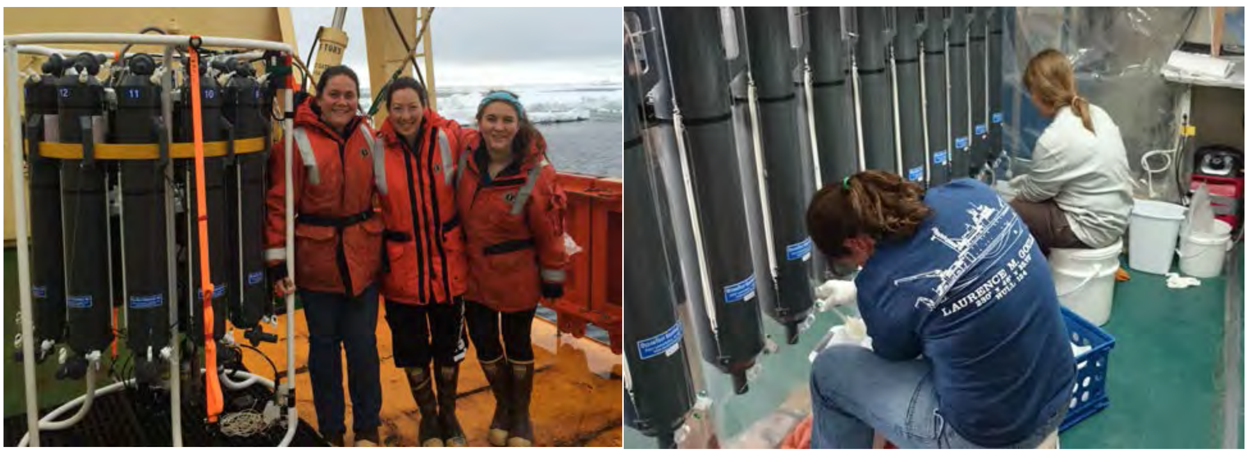

Figure 10. Left: Jess Fitzsimmons, Amber Annett (of the Schofield group), and Laramie Jensen prepare for a deployment of the trace metal clean CTD/rosette. Right: Jess and Laramie filter trace metal samples from the Niskins in the trace metal clean "bubble.