LMG 16-01: 03 Jan -- 17 Feb. 2016 LTER Cruise 24
Weekly Science Report 3
24-31 January, 2016

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

The past week was highlighted by deployments and recoveries. Last Saturday most everyone aboard deployed to Rothera for a day of science, making new friends/colleagues, and renewing old relationships. During our annual calibration minicruise with Rothera colleagues, we successfully deployed an Acoustic Doppler Current Meter for Dr. Alex Brearley (BAS). On Sunday while many spent the early part of the day recovering from the visit, our birders Carrie McAttee and Darren Roberts deployed to Avian Island for their 5-day field camp (see Figure X and their report below). Last evening we successfully recovered our long term physical oceanography mooring, in a fortuitous area of open water, surrounded by several large icebergs and bands of sea ice.

Thanks to Captain Stelly and his officers for surgical ship positioning to recover a badly snarled mooring line, to ET Alec Chin for ranging and interrogating the mooring releases and to MPC Lindsey "Eagle eyes" Loughery, for sighting the mooring, with its pale tiny white balls (floats), so easy to spot in ice-flecked waters.

Figure 1. The LMG near Adelaide Island taken by the ORCAS Gulfstream-V Jan. 27. Photo courtesy: Project ORCAS.

This week we also supported an overflight by the O_2/N_2 Ratio and CO_2 Airborne Southern Ocean Study (ORCAS), a NASA sponsored project of atmospheric sampling and remote sensing based out of Punta Arenas. We collected air samples and provided optical ground truth for the plane's sensors (see C-019 report below). Fig. X shows the LMG from the aircraft last Wednesday.

Individual component reports:

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

Our work during third week of LTER 16-01 included research at Avian Island, where we occupied a field camp for 5 days from January 24-29, 2016 (Figure 2). With help from a crew of ASC folks and grantees, our camp set-up was very successful and quick. During our stay we focused primarily on the breeding success and foraging ecology of Adélie penguins. While there, we conducted breeding colony censuses, weighed and measured crèched chicks, as well as diet sampled adult Adélie penguins (Figure 3). In addition, we completed full island surveys for nesting Southern Giant Petrels, Blue Eyed Shag and marine mammals. We collected South Polar Skua fecal samples, Adélie chick feet for stable isotope analysis, Blue Eyed Shag boli, as well as excrement material from our sediment traps to extract fish otoliths and further examine Adélie penguin diets.

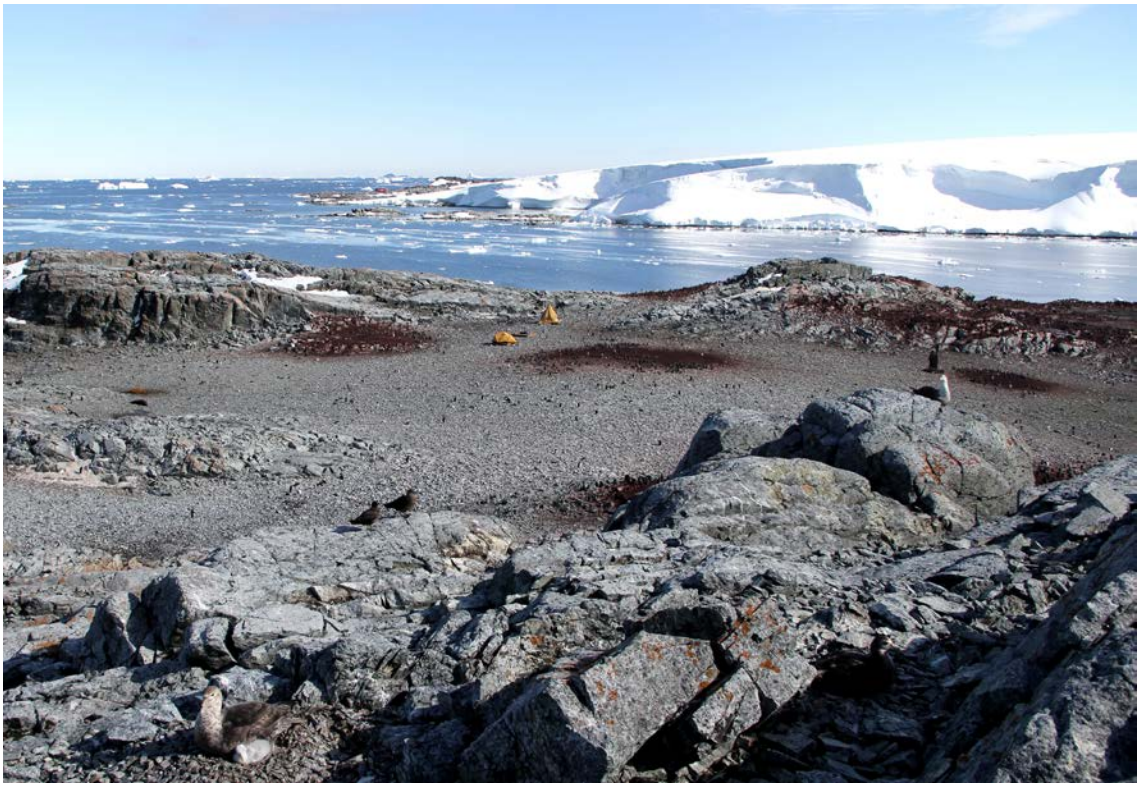


Figure 2. Avian Island camp site with Southern Giant Petrel nest and chick in foreground. The groups of dark shading denote the outlines of Adélie Penguin colonies.

LMG 16-01: 03 Jan -- 17 Feb. 2016 LTER Cruise 24
Weekly Science Report 3
24-31 January, 2016

Figure 3. Adélie Penguin and colonies in background

We'd like to say thanks to Chief Scientist Hugh Ducklow and Marine Projects Coordinator, Lindsey Loughry for all of the logistics planning and check-ins while we were camping. Also, thank you to those who carried our heavy awkward gear during and after camp deployment, helped with communications support, and braved the drenching seas during our pick-up.

After returning to the ship, we've spent time processing and organizing samples in the lab and have begun to process the Adélie Penguin diet samples collected at Avian Island.

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

This week we had a visit from a remote sensing airplane making airborne measurements for the O_2/N_2 Ratio and CO_2 Airborne Southern Ocean Study (ORCAS) (Fig. 4). This project aims to understand the physical and biological processes controlling air-sea CO_2 and O_2 fluxes in the Southern Ocean. The optics cage we have been deploying from the back deck measures light absorption and attenuation in the water (Fig. 4), while the radiometers mounted from on the bow measure light leaving the ocean. All these measurements can be correlated to concentrations of chlorophyll-a, colored dissolved organic material and suspended minerals in the water. The flyover on Monday was a comparison flight: the airborne sensor also measures light leaving the ocean and will use the simultaneous in-situ measurements we took to make any necessary corrections and calibrations. This way, the remote sensing instruments can measure much wider areas of the ocean than we can from our ship.

Figure 4. ORCAS flyover (left) with simultaneous optics cage deployment (right). MT Carmen Greto and UConn post-doc Shungu Garaba pictured.

Carly's iron-addition incubation experiments continue to run successfully (**Fig. 5**). When heavy ice conditions prevent her from collecting water from the trace metal towfish, she samples from 10 m below the surface using the trace metal-clean rosette. She has completed three incubations, has one in progress, and two more scheduled before the end of the cruise.

Figure 5. UNC PhD student Carly Moreno filtering water for her incubation experiments.

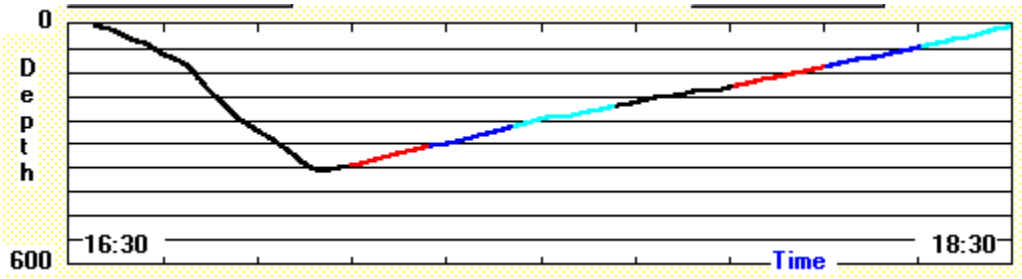
C-020. Zooplankton Component (Debbie Steinberg, VIMS; PI)

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

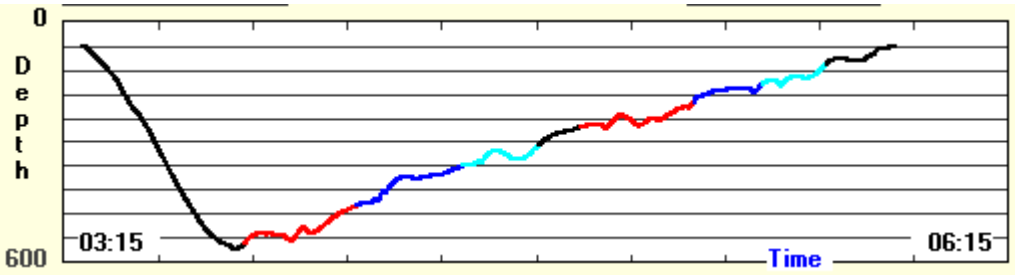
During the third week, we completed our second Process Study. The study was a mini-time series that was designed to focus on an ice-covered site. However, the ice was blown away by high winds a few days into the study. The site was dominated by arrow worms and copepods. Juvenile krill, *Euphausia crystallorophias* and *Thysanoessa*, were also abundant. Larval fish, including silverfish, were mostly absent in our samples. We conducted fecal pellet production rate experiments on *E. superba* comparing ice-covered and open-water areas. We continued to collect animals for gut fluorescence, mercury contamination, and the VIMS Invertebrate Collection.

LMG 16-01: 03 Jan -- 17 Feb. 2016 LTER Cruise 24
Weekly Science Report 3
24-31 January, 2016

We managed to deploy a set of day/night MOCNESS tows in an ice-covered area, a first for our group. Typically, we send the nets down to our desired depth, and then begin releasing the nets as they come towards the surface. We would like the nets to come up at a constant rate so that they sample each depth equally. Maintaining a constant rate is largely dependent upon the ability of the ship to maintain a constant speed (2 knots for 3 hours). The following graph shows the MOCNESS depth over time, with each color indicating a different net. Each net samples a discrete depth interval and the nets come up at a fairly constant rate, as shown by the straight line.



This is a best case scenario. However, when the ship is traveling through ice, it is very difficult for the ship to maintain a constant speed. When the ship approaches a large ice flow, it speeds up slightly and this causes the nets to ascend more quickly. When the ship hits the ice, it slows down, causing the nets to sink. As the ship makes its way through the ice flow, the ship may suddenly speed up or slow down, depending on the thickness of the ice. When the ship breaks free of the ice, the ship speed increases again. This results in the net quickly rising or sinking with the ship speed, as the following graph shows.



While the tow was not optimal, it was still an amazing feat considering the conditions we were sampling in. The ECO crew and ASC staff are commended for their efforts and skill working in such a challenging environment.

Photo credits: Miram Gleiber

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.

In addition to continuing our visual survey effort of cetaceans, Erin has just finished auditing the 7.5 hours of video footage that we obtained from the multi-sensor suction cup tag we deployed on a Humpback whale earlier this month in the Palmer Deep Canyon. Erin focused on creating a detailed log of underwater foraging behavior. We were especially interested in recording video footage and collecting fine-scale movement data during coordinated bubble net feeding events. This video footage is the first of its kind documenting this type of feeding behavior in Antarctic Humpback whales. Erin documented many occurrences of both bubble net and lunge feeding events, and in some cases the underwater visibility was good enough to observe other whales in the video frames. Throughout most of the 7.5 hours the tagged whale was travelling and foraging with at least one other whale, but at one point up to three other individuals were present. Other notable behavior included vocalizations and pectoral fin slapping on the surface of the water. Krill were frequently observed rushing by the forward facing camera just after lunge events.

While she is assisting Ari with this work, Erin is co-advised by Bill Fraser and is currently working on a master's project looking at the foraging behavior of Adelie and Gentoo penguins in relation to inter-annual krill recruitment variability at Palmer Station. The larger context of this study is to gain a better understanding of the physical and biological drivers of the opposing population trends of Adelie and Gentoo penguins in the Palmer region. The purpose of Erin's study is to assess whether these two sympatric species partition foraging habitat (e.g. dive depth, location, time of day) and to determine how inter-annual variability in krill recruitment affects this relationship. To answer these questions, Erin is using data obtained from satellite and time-depth recording tags and penguin diet samples collected by Bill Fraser's team over the past six breeding seasons (2010-2015). In her analysis of diet data so far, Erin has found little variation in prey preference (type or size) between species. Size-class frequency distributions of krill found

in diet samples of both species show a non-random, forward progression of dominant krill size-classes from one year to the next, in accordance with previous studies that have found penguin diets to reflect cyclical krill-recruitment patterns. Erin has just begun a spatio-temporal analysis of penguin foraging locations but so far it look as if that there is little overlap between the two species core foraging areas despite inter-annual changes in prey.

Erin and Logan (at Palmer Station) are putting forth a coordinated effort to share this research on a blog: All about that baseline: Cetacean research along the Western Antarctic Peninsula (blogs.oregonstate.edu/ltercetaceans)

Figure 6. Screen-shot from a video recording multi-sensor tag deployed on a humpback whale in the Palmer Deep Canyon. The tag has two cameras (one facing forward and the other 180 degrees in the opposite direction) and was placed on the whale at such an angle that the top image shows looking across the left side of the whale while the bottom view points down the right side of the whale. The VHF radio antenna on the back of the tag can be seen in the bottom frame. An Antarctic krill is visible in the top image, and after consulting with Joe Cope, was determined to be an adult and pregnant female.

LMG 16-01: 03 Jan -- 17 Feb. 2016 LTER Cruise 24
Weekly Science Report 3
24-31 January, 2016

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.

Just before arriving at Rothera for our annual science and social visit, we completed the first half of the hydrographic-ecological and biogeochemical survey of the PAL-LTER grid. For our group, this enabled a quick comparison this year's bacterial leucine incorporation rates (an index of growth rates), influenced by extensive sea ice cover, with previous years (Figure 7). The histograms show the highest rates are generally over the coastal and shelf regions, and that 2014 was anomalously high (also higher than any year since this survey began in 2003). The particular conditions supporting the high rates in 2014 are under investigation. Interestingly, 2016 rates are also high, even under the sea ice cover. Like other ecological properties, there is a long "tail" of low rate sites, which we hypothesize harbor bacteria waiting for brief injections of organic matter from phytoplankton, krill or sea ice algae.

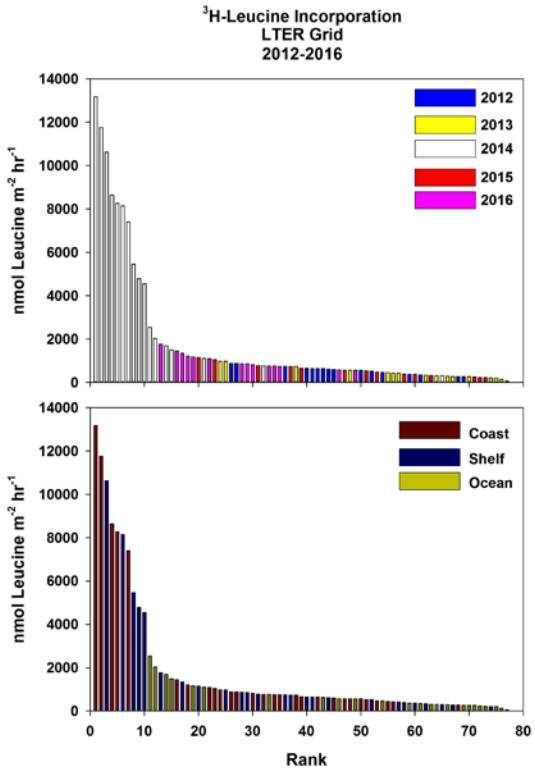


Figure 7. Bacterial incorporation of 3H-radiolabelled leucine, an index of bacterial community growth rates on the LTER grid (200-600 lines), 2012-2016.

Figure 8. C-024 team members Emilie Schattman and Griffin Whitlock at Rothera party, Jan 23, 2016.

This week we introduce team members Emilie Schattman and Griffin Whitlock, 2016 graduates of Barnard and Columbia College, respectively, with majors in Environmental Sciences. Emilie and Griff both talented musicians, stole the show at the annual dance party at Rothera (Figure 8).

LMG 16-01: 03 Jan -- 17 Feb. 2016 LTER Cruise 24
Weekly Science Report 3
24-31 January, 2016

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

The trace metals group continues to enjoy successful sampling and safe deployments. We have completed all planned stations on the 200 line, including the in/out of the ice time-series station at 200.000 and the ice edge station at Process Study 2. We have also targeted sampling inside Marguerite Bay at station 200.-080 and along a trace metal towfish surface transect in order to constrain glacial inputs to the large metal inventory in Marguerite Bay.

Figure 9. Laramie Jensen, PhD student, Texas A&M Oceanography

This week we feature our team-member Laramie Jensen (**Figure 9**), a first year graduate student studying Oceanography at Texas A&M University in the Fitzsimmons lab. As an undergraduate chemistry major she became inspired by the complex and often poorly understood chemical properties of trace metals in the ocean, particularly their connection to biological and physical dynamics. As part of the trace metals team on LTER, she assists with sampling and analysis on every level. She is also working on two independent experiments that look critically at properties of colloidal Fe exchange. Specifically, she is testing whether Fe colloids can be preserved intact over the timescale of weeks and also what the exchange and reformation kinetics of Fe colloids are in fresh seawater samples. The outcome of these experiments will be essential for designing future trace metal experiments investigating the chemical exchange and bioavailability of colloids to marine phytoplankton.

Our biggest discovery this week comes from our phytoplankton incubation results. At each station, we incubated mixed layer phytoplankton communities with and without added iron (Fe, 2nM). While significant amounts of Fe are suppled from Antarctic continental sources (sediments, glaciers, sea ice), phytoplankton communities in the open Southern Ocean, remote from these sources, often struggle to acquire sufficient Fe to grow at optimal rates. We aimed to measure the resulting gradient of phytoplankton Fe stress occurring across the LTER sampling grid. As the results in Figure 10 show, nearshore stations (e.g. 400.040) did not show a phytoplankton response to added Fe, which would be indicated by a darkened pigmentation of the "Fe" incubations (+2nM Fe) as compared to the control "C" incubations (no added Fe). However, more offshore at station 400.200, there was a clear increase in phytoplankton productivity in response to added Fe, as would be expected of open Southern Ocean phytoplankton communities. Surprisingly, the phytoplankton at nearshore station 500.060 also showed a response to Fe additions that would indicate some Fe stress, despite the proximity to continental Fe sources nearshore.

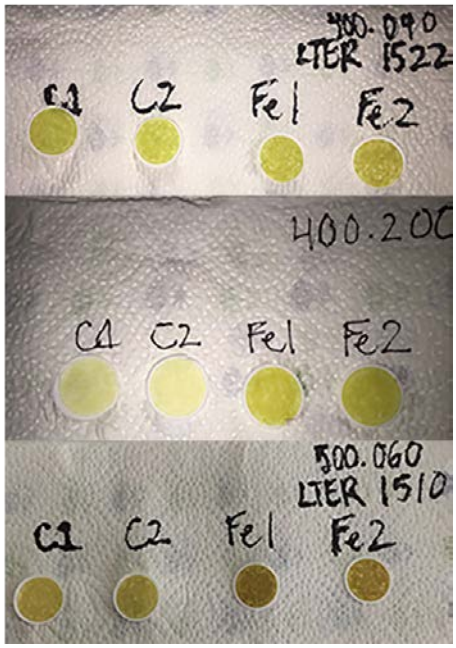


Figure 10. Fe-addition incubation results. Seawater was incubated in duplicate control (C) treatments (no added Fe) and +Fe (Fe) treatments (2 nM added Fe) for 5-7 days. More intensely pigmented +Fe filters than C filters (middle and bottom) indicate the presence Fe stress in those phytoplankton communities, while similarly pigmented C and Fe filters designate that Fe is replete at those stations (top). Full HPLC pigment analysis, macronutrient concentrations, and molecular analysis back in the lab will tell a more complete story of community composition and nutrient stress across the grid.