

LMG 12-01: 29 Dec. 2011 – 07 February 2012 LTER Cruise 20
Weekly Science Report I

Palmer Long Term Ecological Research Project: Looking Back in Time Through Ecological Space.

Cruise Overview:

The overall long term objective of Palmer LTER is to understand the mechanistic linkages by which climate, physical oceanographic forcings and sea ice extent and duration control ocean productivity, food web processes, krill and penguin recruitment and carbon biogeochemistry in the marginal sea ice zone of the western Antarctic Peninsula (WAP) region. The WAP is one of the most rapidly-warming regions on the planet, and we have documented responses throughout the foodweb from phytoplankton to penguins. The annual oceanographic cruise (now in our 20th year) provides a large scale regional view of physical-trophic-biogeochemical processes in the region, and contributes to a time series of ecosystem transformation in response to regional warming and sea ice loss.

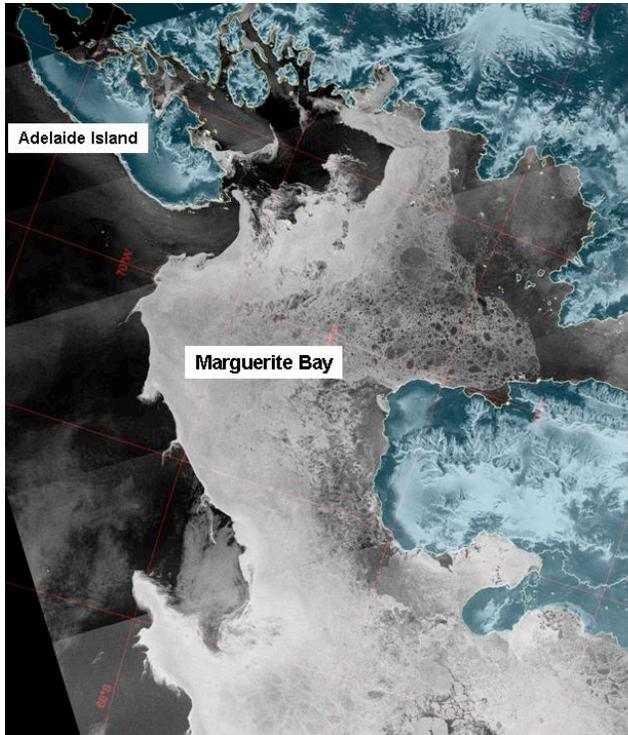
This cruise is about equally divided between 1) occupying standard LTER stations along the regional grid extending from Palmer Station to Charcot Island and from the inshore coastal region to deep (>3000 m) water off the continental shelf break in the Antarctic Circumpolar Current, and 2) conducting three, 3-4 day process studies along the peninsula. This year's process studies are focused on the relationships among bathymetry (submarine canyons), physical oceanographic forcing, krill abundance and penguin foraging. During the first few days of the cruise, we completed Process Study I in the vicinity of Palmer Station (**Figure 1**)



Figure 1. Map of stations occupied during LTER cruise Process Study 1. The rectangular pattern is the cruise track for the acoustic zooplankton survey conducted on 04 January. Large numbers of krill were observed on survey line WH3-WH4. The red oval is the foraging region for Adelie penguins nesting in the Palmer Station area. The white dashed line roughly indicates the axis of the Palmer Deep submarine canyon. LTER grid station 600.040 (bottom left) is in the deepest part of the Palmer Deep (1200 m). Diamonds show CTD stations occupied during Jan. 4-7. Palmer Station is just off the top of the diagram, above the white dashed line.

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As we started our cruise, ice imagery (**Figure 2**) kindly supplied by Paul Morin at the Polar Geospatial Center, University of Minnesota indicated a late ice retreat and extensive ice cover across the southern part of our study area, particularly around Charcot Island. We'll be keeping close watch on the ice as we begin to work our way south.



January 08, 2012
RadarSat image of sea
ice coverage south of
Adelaide Island.

Image supplied by Paul
Morin, Polar Geospatial
Center, Univ. of
Minnesota

As always, we received outstanding help from the Raytheon, Edison Chouest and Agunsa staff in Punta Arenas, at Palmer Station and aboard the ship. The annual LTER cruise is a large and complex operation and we benefit greatly from the accumulated expertise and corporate memory of many dedicated colleagues and friends.

Individual component reports:

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

Field Team Members: Jen Mannas and Kristen Gorman

The objective B-013's component of this year's LTER cruise is to continue the long-term data set of at-sea bird surveys to assess abundance and distribution across the LTER regional study grid. In addition, we plan to continue studies of Adélie penguin breeding and foraging ecology at Avian Island, a southern study area located in Marguerite Bay that provides a higher latitude comparison with similar studies conducted at Palmer Station.

The port call at Palmer Station in prep for LTER 1201 was efficient and productive. Both Palmer Logistics and LMG Marine helped us to load our gear for the Avian Island field camp in the LMG hold and organize space in the lab for our work over the next month. During the first week of the cruise, we surveyed seabirds from the bridge of the LMG during the process study at 600.040 and within the Palmer Deep Canyon area. We continued to survey along the 600 and 500 lines, in addition to assisting with whale tagging and biopsy operations.

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We would like to thank both RPSC and ECO personnel who have helped us get started on what we expect will be a very productive cruise. In particular, MPC Stian Alesandrini organized a last minute field gear request from Palmer Station, and ETs Mike Coons and Tony D'Aoust setup an extra monitor on the bridge of the LMG for our bird survey work.

B-019: Phytoplankton Component (O. Schofield, Rutgers; PI)

Team Leader: Oscar Schofield (Rutgers Univ). Field Team Members: Kaycee Coleman, Marie Séguret, Christian Laber, Amelia Snow, Andrew Irwin

The objective of this component is to understand how the ocean physics regulates overall phytoplankton productivity and community composition and how these dynamics affect the higher trophic levels of the food web. The team is focused on collecting an extensive set of measurements during the cruise. A full suite of bio-optical properties were characterized at each station with measurements of the inherent (absorption, attenuation, backscatter) and apparent (spectral irradiance, radiance) optical properties. The inherent optical properties are measured with WetLabs absorption/attenuation meter (AC-9) and WetLabs EcoPucks. The visible and ultraviolet spectral radiometry is measured with Bio-Spherical Profiling Reflectance Radiometer (PRR) and Profiling UltraViolet sensor (PUV). Optical closure between the inherent and apparent optical properties is checked using the Hydrolight radiative transfer program onboard the ship. These profiling measurements are complemented with the historical B-019 LTER time series measurements of chlorophyll *a*, HPLC, CHN, phytoplankton productivity ascertained via ¹⁴C-radioisotope, and photosystem II quantum yield (Fv/Fm). The measurements are augmented with samples collected for dissolved and particulate trace metal concentrations. This year, these micronutrient samples are augmented with measurements of particulate barium and RNA. B-019 is also adding this year measurements of particulate iodide, which in conjunction with B-045's measurements of dissolved iodide will allow Dr. Tim Jickell's at the Univ of East Anglia to test his approaches to estimate water column new production. Finally in collaboration with Professor Andrew Irwin we have added measurements of particle size distribution and microbial community composition at each station using Beckman Coulter Multisizer 3 and Fluid Imaging Inc. FlowCAM unit respectively.

The first week of ship operations focused on the phytoplankton dynamics in the deep canyon adjacent to Palmer Station. Station sampling, described above, was augmented with two incubation studies. One set of incubation studies measured the response in the microbial communities with the addition of iron and zinc. A second set of incubations assessed the relative uptake of the nitrate, ammonia, or urea by the phytoplankton carbon using stable isotopes. Results from the process study showed that the Palmer canyon was in the midst of a phytoplankton bloom however over the experiment the chlorophyll concentrations appeared to drop by a factor of two. Whether this was due to heavy grazing by krill, increased wind mixing or nutrient limitation will be a focus of data analysis efforts. Phytoplankton communities were dominated by relatively small (<10 micron) flagellates, which were largely associated with lower salinity water in the local area (<34). FlowCAM imagery suggested the bloom was dominated by cryptophytes. The high biomass resulted in high rates of carbon fixation in the upper mixed layer (3-5 mgC/m³/h) and the net result was a turbid water column with the 1% light level found in depths shallower than 25 m throughout much of the study area. Dr. Mathew Johnson (WHOI) requested samples if we encountered any flagellate blooms during the cruise for genomic analyses; therefore a full set of microscope slides and samples were collected for Dr. Johnson.

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B-020. Zooplankton Component (D. Steinberg, VIMS; PI)

Field Team Members: Joe Cope, Kim Bernard, Kate Ruck, Lori Price, Karen Stamieszkin, Frances Armstrong.

The overall objective of our component in Palmer LTER is to understand the role that zooplankton community structure plays in biogeochemical cycling of carbon and nutrients, and the effects of climate change on zooplankton communities in the continental shelf sea of the west Antarctic Peninsula. This year, with three process study stations, we emphasize the role that zooplankton play in the biological pump (grazing, particle or fecal pellet production, and diel vertical migration).

In the first week, we completed full stations along the LTER 600 and 500 lines and concentrated our operations at a special 3-day process study station situated near the Palmer Deep canyon area and LTER grid point 600.040. At each station we performed a pair of net tows for larger macrozooplankton (e.g., krill, salps) and smaller mesozooplankton (e.g. copepods). Animals from the macrozooplankton tows were identified and counted on board, while the presence of taxonomic groups was noted in the mesozooplankton samples. We also took samples at selected stations for zooplankton lipid and gut fluorescence analyses. At the process study station, we performed depth-stratified zooplankton sampling using the MOCNESS (Multiple Opening-Closing Net Environmental Sensing System) to investigate depth distribution of the abundant taxa over a diel cycle. Despite the almost constant light, we did detect diel vertical patterns in some taxa (e.g., *Thysanoessa*). High numbers of krill were caught in some MOCNESS nets, tempering doubt that the MOCNESS can adequately sample this important group. We also performed a dilution experiment to measure microzooplankton grazing. The B-045 flow cytometer will allow us to analyze the samples and to interpret the results while still at sea. Several gut evacuation rate experiments were performed on copepods. While we have conducted this type of experiment before on larger zooplankton, this is the first attempt on small animals, which are closer to the base of the food web. These experiments, coupled with gut fluorescence measurements of the larger zooplankton mentioned above, will allow us to quantify removal of primary producers by the zooplankton community. A bio-acoustic survey during the process study mapped out large aggregations of krill in the canyon, which correlated with findings of concurrent LTER whale distribution and penguin foraging studies. Finally, we began to determine the developmental rates of dominant copepod species at different temperatures; copepods in warmer temperatures tend to develop quicker, but at smaller sizes, directly affecting the amount of carbon they assimilate over their life cycle.

The crew/RPSC support on the ship has been excellent. The marine science technician has provided us with some essential equipment that was not listed on the SIP. The deployment of our net tows went smoothly with the expertise of the vessel pilots, marine technicians, and winch operators. The MOCNESS is a particularly tricky gear. The electronic technicians assembled the MOCNESS system and worked out all bugs by the second tow. We are very thankful for their efforts.

B-045: Microbial Biogeochemistry Component (H. Ducklow, MBL; PI).

Team Leader: Hugh Ducklow. **Field Team Members:** Matthew Erickson, Cat Luria, Pam Moriarty, Sevrine Sailley, Mike Stukel.

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The objective of this component is to obtain a mechanistic understanding of the carbon cycle along the Western Antarctic Peninsula, and the roles of heterotrophic bacterioplankton in these geochemical transformations. We are also concerned with possible responses of the microbial foodweb and biogeochemical transformations to climate warming. Our routine measurements include heterotrophic and autotrophic microbial abundance by flow cytometry conducted on-site, bacterial production by leucine incorporation, dissolved inorganic carbon and nutrients, dissolved inorganic carbon and dissolved oxygen. We are collecting samples for oxygen-18 analyses to determine glacial and meteoric inputs to seawater, in collaboration with LTER colleague Dr Mike Meredith (BAS-UK), and for iodine speciation as an index of new production, in collaboration with Prof. Tim Jickells, Univ. of East Anglia, UK. We are in the fifth year of a collaboration with Prof. Mike Bender, Princeton, and his PhD student Kuan Huang, who determine the triple isotopic composition (O-16, 17, 18) of dissolved oxygen in seawater, to estimate rates of gross primary production. Finally, we deploy a time-series sediment trap to collect settling particles and determine the export flux from the upper ocean.

We have two new projects this year: MBL postdoc Mike Stukel is measuring the Thorium-234 disequilibrium to estimate particle export from the upper 200 meters. The Thorium results will also be used to calibrate the sediment trap, an exercise started in 2009. Brown University PhD student Cat Luria is starting her dissertation research on determinants of bacterial community structure during the winter-to-summer transition, when the upper ocean plankton community shifts from one dominated by heterotrophs and chemoautotrophs to a foodweb based on photoautotrophic metabolism, with large numbers of heterotrophic bacteria.

During the first week of operations, we conducted most of the aforementioned measurements at LTER grid stations 600.040, 600.100, 600.200, 500.200, 500.100 and 500.060, and at all five Process Study 1 Stations. Preliminary results from flow cytometry and leucine incorporation experiments at 11 stations suggest bacterial abundance and activity are still rather low, consistent with observations by our group at Palmer Station, and with the late ice retreat.

LTER Guest Component: Distribution, abundance, and movement patterns of baleen whales within the Palmer LTER study area. PI: Ari Friedlaender.

Through a combination of visual surveys and satellite telemetry, the aim of this project is to better characterize the distribution and movement patterns of baleen whales within the LTER study area. By linking the movement patterns and distribution of these krill predators to oceanographic conditions and the historic feeding areas for Adelie penguins, we can begin to understand the ecological relationships that are likely to be affected by warming conditions in the Western Antarctic Peninsula region.

To date, over 90 observations of over 180 humpback whales have been made. As well, two satellite-linked Argos tags have been deployed on humpback whales (**Figures 3, 4**) in the vicinity of Palmer Station. Their movement patterns suggest both residency in the krill-rich region around Anvers Island and longer-range movements to find other high density krill areas in which to feed.

Figure 1 Satellite tag deployed on an adult humpback whale. The tag can be seen on the flank directly below the dorsal fin.

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Figure 2 Satellite-linked locations of two humpback whales and their movements in the region of Anvers Island.

O-405: Physiological and Ecosystem Structure Forcings on Carbon Fluxes in the Southern Ocean Mixed Layer (Nicolas Cassar, Duke Univ., PI)

Field Team Leader: Bruce Barnett. The quadrupole mass spectrometer and associated plumbing have been installed and are working well. I am measuring gases dissolved in seawater from the Gould's underway system. In particular I am measuring Nitrogen (both masses 28 and 29), Oxygen, Argon, and Carbon Dioxide (masses 44 and 45). While at one of the stations, I attempted to measure DMS using a section of microporous tubing with mixed results.