LMG 12-01: 29 Dec. 2011 – 07 February 2012 LTER Cruise 20
Weekly Science Report 3: 17-24 Jan 2012

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

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.

In the past week, we completed sampling along the LTER 200 line and our second process study in the Avian island/Marguerite Bay region. This study included a five-day field camp on Avian Island to assess the large Adélie penguin population (see B-013 Report below). Our annual scientific visit to the British Antarctic Survey Rothera Base included joint operations at three fixed stations in Ryder Bay, daylong personnel exchanges between ship and base, the annual soccer game (we lost) and a party in the evening. After the Rothera interlude, we proceeded into the south region of our study area, much of which remains covered by sea ice. After occupying regular grid stations on the 100, 000 and -100 lines we plan to conduct our third process study somewhere within the ice edge (**Figure 1**).

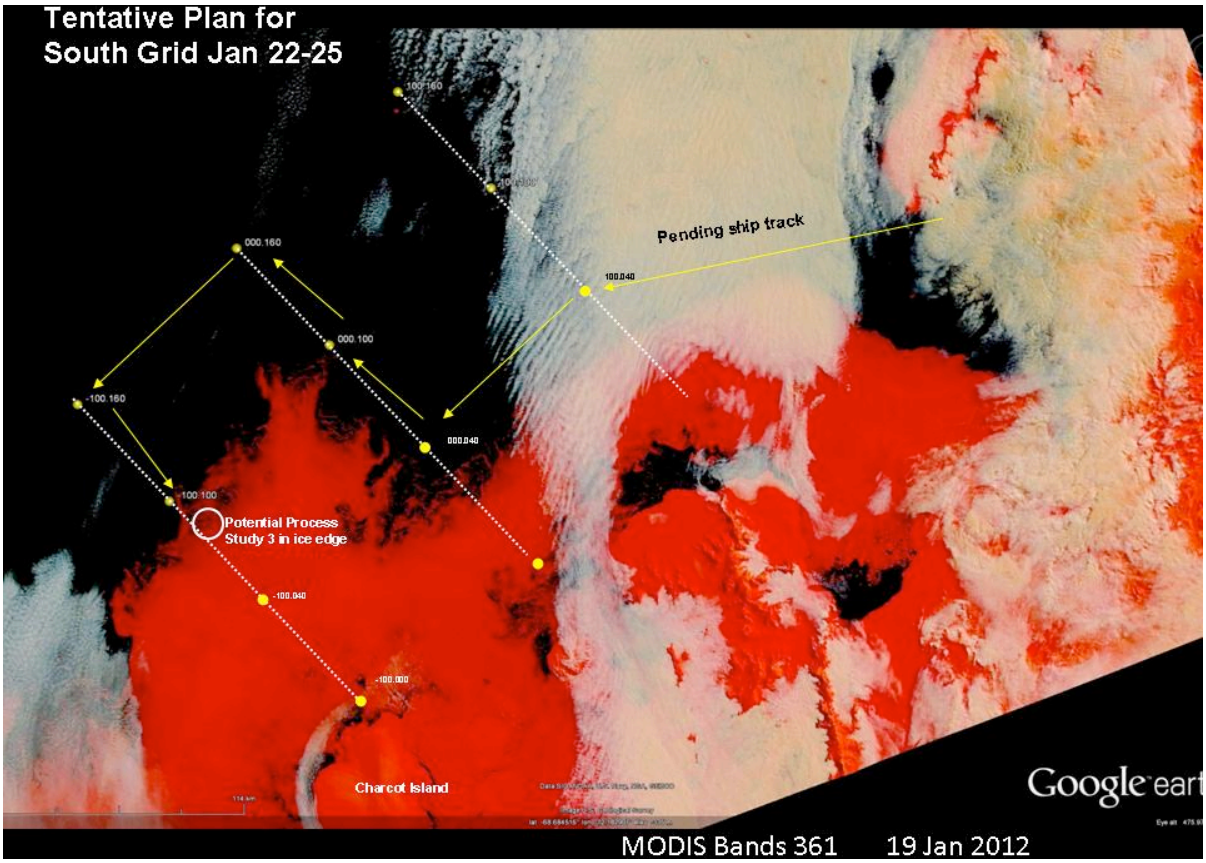


Figure 1. Map of sea ice (red) and oceanographic operations and tentative process study in the southern region of the Palmer LTER study area.

During the week we benefitted from excellent support by the Raytheon science support team and the officers and crew of the LMG. We're also grateful for imagery support from Paul Morin, Polar geospatial Imagery center, Univ. Minnesota.

Individual component reports:

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

The objective B-013's component of this year's LTER cruise (LMG 1201) 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.

Our work during the second and third weeks of LTER 12-01 included research at Avian Island, where we occupied a field camp for 6 days, January 14-19, 2010. The camp deployment went extremely smoothly, we had excellent weather for landing and hauling gear onto the island. The camp set-up was greatly expedited by help from both grantees and RPSC marine. During the Avian Island field camp we primarily work on the breeding and foraging ecology of Adélie penguins. Thus, we deployed PTT satellite tags, surveyed breeding colonies, weighed and measured chicks, and diet sampled adult Adélie penguins. In addition, we surveyed the entire island for marine mammals, giant petrels, and cormorants. We would especially like to thank the RPSC marine crew for help with the camp deployment and for communications support. MPC Stian Alesandrini consistently awaited our twice daily safety call-ins and greatly helped with the camp logistics.

After returning to the LMG on 1/19/12, we have continued to conduct at-sea bird surveys from the bridge of the LMG while transiting on the 200, 100, and 000 lines of the LTER regional grid. In addition, we have been in the lab processing our diet samples from Avian Island, which includes measuring the size distribution of krill and searching for otoliths to identify and age fish consumed by penguins at Avian Island.

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 third week of operations continued the spatial sampling of the WAP with the traditional LTER phytoplankton measurements. The data in the region showed variable phytoplankton productivity rates. The communities showed a shift from flagellates to chain forming diatoms in the north. These traditional measurements are augmented with several other efforts. At the second process station, we conducted the second nitrogen addition experiment. The first estimates of uptake kinetic parameters for ammonium ($NH4+$), nitrate ($NO3-$), and urea in the Western Antarctic Peninsula (WAP) region are currently being measured. Nitrogen (N) and carbon (C) uptake experiments using dual-labeled 15N/13C isotope tracer techniques and another will be conducted in the northern WAP region near Palmer Station to determine general cycling of nitrogen, uptake rates of various nitrogen sources ($NO3-$, $NH4+$, and urea), and preferential selection of nitrogen types by different phytoplankton communities along the WAP.

Additionally there have been significant efforts directed to glider operations over the last week. One deep-water glider (1000-m class) had been launched from Palmer Station on November 21st. The glider headed north and sampled the shelf-slope waters north of Anvers Island. The deep-water glider was then sent south and did a fly-by of the Lamont Doherty moorings prior to their recovery. The glider transected down to the mouth of Marguerite Bay where it waited until the ice that had congested the bay was blown out. The glider was then directed to Rothera Base where the British Antarctic Survey recovered it on January 21st (**Figure 2**). This is the first time two Antarctic land bases have been linked by an autonomous robot. The glider was transferred back to the Gould during our visit to Rothera. This demonstrates the potential of these technologies to survey the entire peninsula with no major ship support. The mission collected to close 10,000 profiles. This operation was complemented by a second glider effort conducted near the penguin rookeries south of Avian Island. A shallow water glider (200-m class) is adaptively surveying the penguin foraging locations (based on penguin mounted satellite tag GPS locations). The glider will continue to sample the Avian island rookeries when the RV Gould is conducting Process study 3 at Charcot Island.

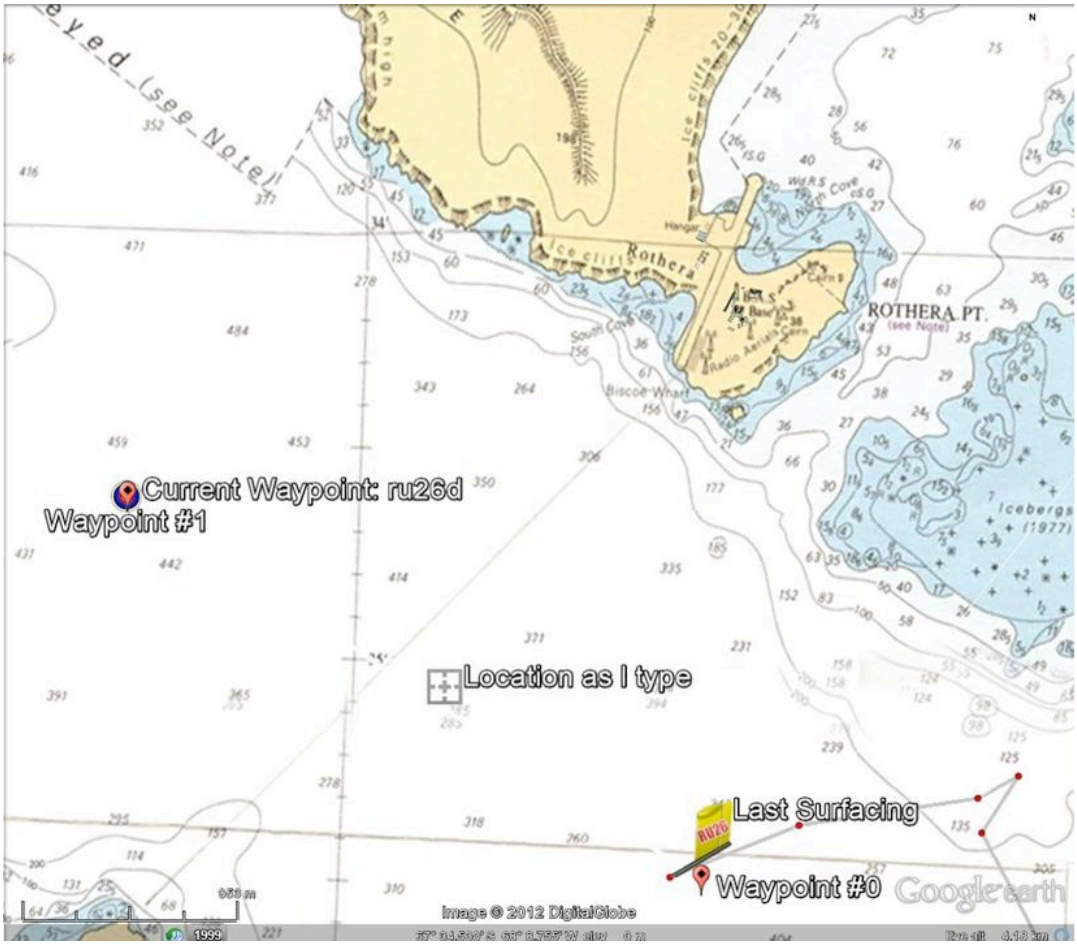
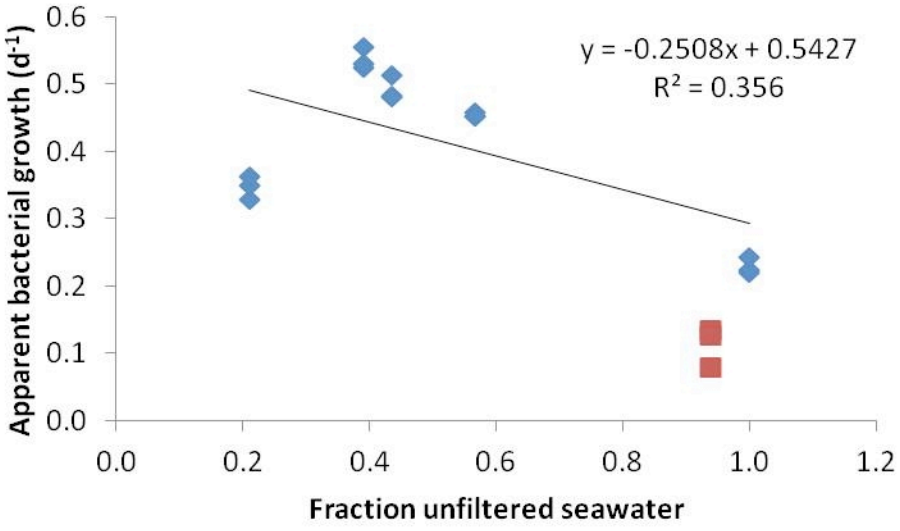


Figure 2. The location of the glider (indicated by the tail) as it approached Rothera Base January 20. The glider spent 24 hours sampling the Rothera Antarctic Time Series (RATS) CTD station (Waypoint 1) for 18 hours before being recovered by the British Antarctic Survey.

B-020. Zooplankton Component (D. Steinberg, VIMS; PI)
Field Team Members: Joe Cope, Kim Bernard, Kate Ruck, Lori Price, Karen Stamieszkin, Frances Armstrong.

During the third week of LMG12-01, we completed full stations along Pal-LTER grid lines -100, 000, 100, and 200. Overall, this year's sample contents varied from the last several years. This year's samples were characterized by the dominance of krill, *Euphausia superba*, particularly juveniles, and the relative scarcity of salps, *Salpa thompsoni*. This may be the result of a cyclical trend.

We have made progress with our copepod experiments. We conducted several more gut evacuation experiments and collected copepods for gut fluorescence. We have been working on a key for the identification of live copepods in the field. We can now readily identify *Rhincalanus gigas*, *Calanus propinquus*, *Calanoides acutus*, *Paraeuchaeta antarctica*, and *Candacia* sp. These species have been documented with photographs from a microscope digital camera. While we have had mixed results in obtaining copepodite stages of copepods, we have been able to get several species to lay eggs in the laboratory.



Graduate student Lori Price (Virginia Institude of Marine Science) conducted dilution experiments at the process study stations to measure bulk microzooplankton grazing rates.

Figure 3. Experimental results from a microzooplankton grazing experiment. Dilution of the original sample reduces the ingestion rate, allowing the true grazing rate to be estimated.

Samples were processed using flow cytometry to determine grazing rates on small phytoplankton (<40µm) and bacteria. In dilution experiment one (at Process Study 1, **Figure 3**), grazing rates were not detected on phytoplankton. Microzooplankton only grazed on high nucleic acid bacteria with bacterial growth and mortality rates of 0.5 d^{-1} and 0.25 d^{-1}, respectively. Microzooplankton ingested approximately 22% of the initial bacterial community and 53% of the potential bacterial production.

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.

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. In the past week we continued to collect and process samples along the southern grid lines.

LTER Post-doc Mike Stukel (Horn Point MD and MBL-Woods Hole) has been estimating vertical particle flux by measuring Th-234 deficiency at eight depths spanning the upper 200-m of the water column at most of the primary LTER stations. 4-L samples were spiked with a tracer concentration of Th-230, which was co-precipitated with the naturally occurring Th-234 on manganese oxide particles (Pike et al. 2005). Particles were collected on quartz filters and counted onboard using a Riso low-level beta counter. Background counts and yield analyses will be conducted on land following the cruise. Carbon:Th-234 ratio was also measured on particles collected in the LTER time-series sediment trap. In addition, at the same grid stations, we have measured 15NO3 uptake at the surface and 10% light levels to compare new production to particle flux (Figure 4).

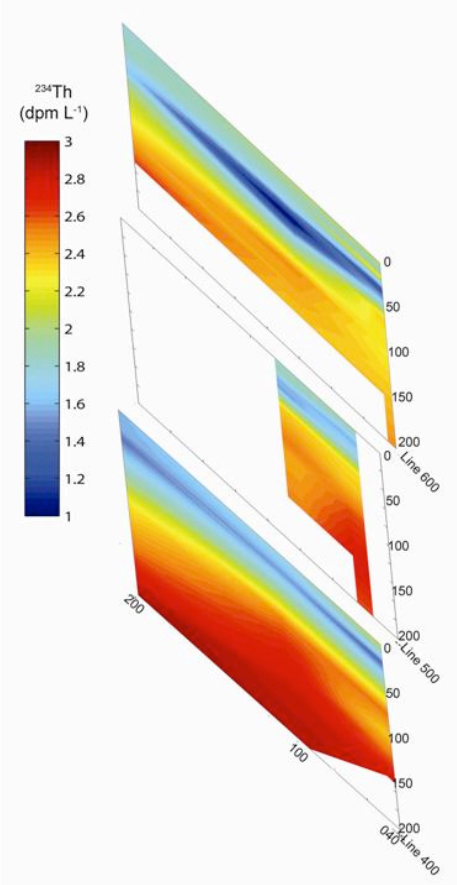


Figure 4. Thorium-234 deficiency relative to parent U-238 in seawater along the 600, 500 and 400 lines. The x-axis is distance offshore (km), and the y-axis is depth (meters). Thorium is removed from the surface ocean by adsorbing to sinking particles. Thus the greater the deficiency, (blue), the more particle removal.

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 Adélie 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, 118 sightings of 233 humpback whales have been made. As well, three satellite-linked Argos tags have been deployed on humpback whales in the vicinity of Palmer Station and off the southern tip of Adeliade Island . 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, but remaining in coastal waters around the islands of the Western Antarctic Peninsula. Two sightings of four minke whales have also been made, and one sighting of six killer whales. In general, it appears that the relative abundance of humpback whales is much greater in the northern portion of the study area than to the south in Margeurite Bay. The whale tagged most recently remained near Avian Island for one day and then began moving steadily north towards Renaud Island while the animal in the vicinity of Anvers Island has since moved north and east towards the Bransfield Strait (**Figure 5**).

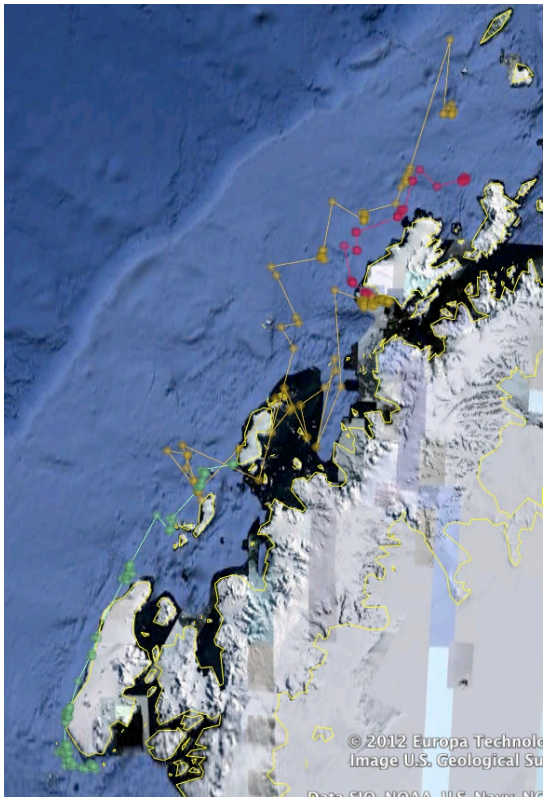


Figure 5. Satellite-linked locations of three humpback whales and their movements in the region between Anvers and Adelaide Island

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.

Measurements of dissolved N2,O2,Ar,and CO2 continued as well as filter collections for RNA analysis. Collection of dissolved oxygen samples from the underway system for Winkler Analysis continued at roughly twice daily. The results will be compared with those of the Gould's Optode measurements. A few dissolved oxygen samples have also been collected simultaneously with the surface CTD collections to determine if there is any significant biological activity in the underway lines. The quadrupole mass spectrometer measured a roughly 5% increase in O2/Ar ratios during the Gould's time in the ice. The ratios return to more normal values as soon as the ship had ventured into open waters.