Weekly Update 3: LMG Cruise 11-01 Palmer LTER
15-22 January, 2011

Photo: LMG 1, Rothera 0. Credit: Lihini Aluwihare, B-114.

Early in the second half our the annual Rothera vs LMG soccer (football) game played on the Rothera airstrip taxiway, Travis Miles (B-019) took assist passes from 3rd Mate Tim Demelo (ECO) and Kristen Gorman (B-013) deep in the British end and drilled a shot toward the goal. The ball dove for the back corner of the net like a Webb-Slocum Glider. LMG led 1-0, our first-ever lead in the decade-long rivalry. The rest of the match was a tense defensive standoff as the Rothera side stepped up its attacks and LMG Goalie Mike Coons (RPSC) and the 16 other LMG defenders bunched to fend off the home team's many shots on goal. As time ran down, exuberant shouts of L – M – G echoed off the glacier behind this southernmost soccer pitch. Our hosts were gracious losers, perhaps secure in their expectation that the Antarctic soccer world would be returned to rights with our next visit.

The Avian Island field camp setup was completed by B-013, RPSC support staff and science party helpers in record time under gorgeous blue skies. See below for details of the 5-day B-013 field camp. Week 3 of our cruise was highlighted by an extended process study. We spent 4 days conducting CTD, net and acoustic sampling in the Adélie penguin foraging region off Avian Island, guided by satellite tags placed on birds by the B-013 team at the start of the week. We occupied stations in both near- and far-field locations (see map) and surveyed the lines between stations with acoustics to obtain higher resolution distributions of penguin prey. The area was characterized by low pCO2, high but patchy diatom biomass and abundant juvenile krill. Salps were captured in every net tow. Sea surface temperatures were high, exceeding 3.5 C in some areas. B-013 deployed a glider for surveying the inshore areas between our triangle and Adelaide Island (see B-013 report and photo below).

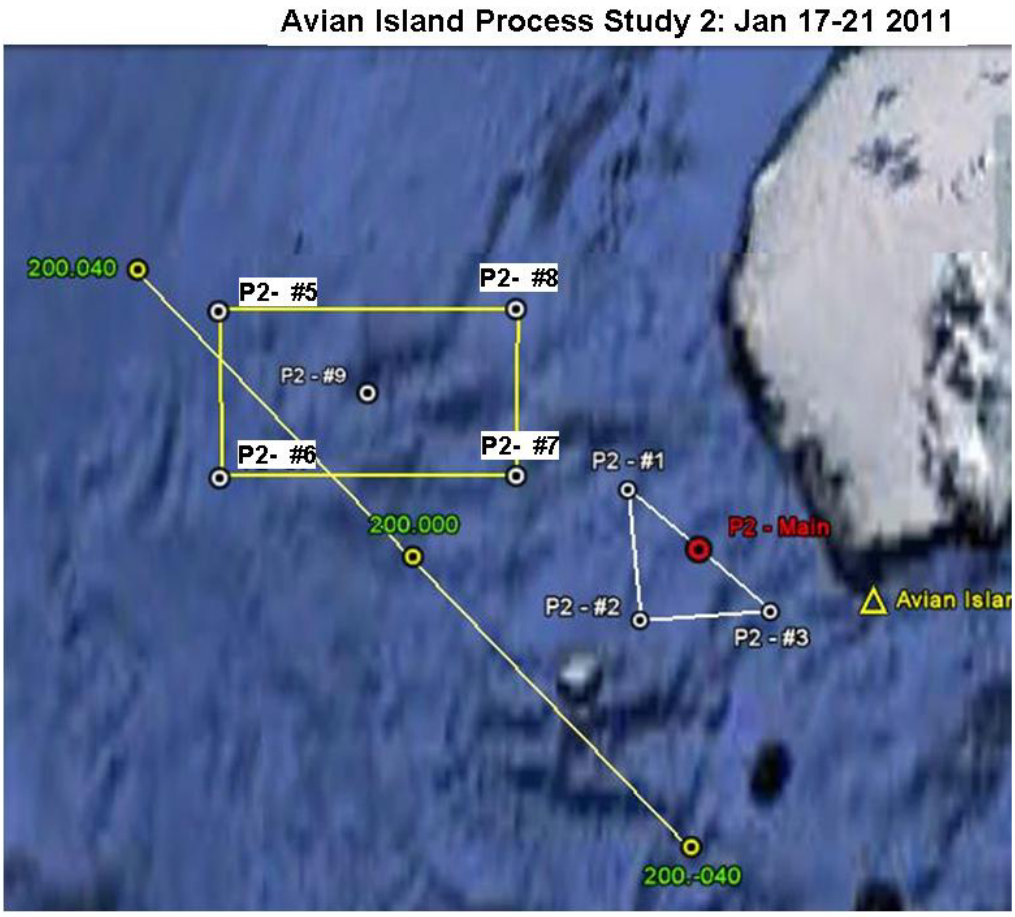

Figure: Map of Process-2 study region near Adelaide Island in the Adèlie penguin foraging region, as estimated from synoptic PTT satellite tag returns. Station P2-Main (red dot) is the center of the 2005-10 PTT dataset. The far-field box encompasses PTT returns from 3 current foraging trips.

Individual reports from the LTER component and guest projects follow with further details.

B-013: Seabird Component. Project Leader: W.R. Fraser. Field Team Members: Shawn Farry (Field technician) and Kristen Gorman (PhD student).

Our work during the third week of LTER 11-01 was performed at Avian Island, where we occupied a field camp for 6 days, January 16-21, 2010. The camp deployment was greatly expedited by help from both grantees and RPSC marine in hauling 6 heavy tent platforms to the island this year for a new camp setup, which worked extremely well. We had excellent weather this week that made our work on the island much easier. 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 MTs and MST Chance Miller, Mereidi Liebner, and Cooper Guest for help with the camp deployment, as well as ET Mike

Coons for communications support. MPC Stian Alesandrini was always awaiting our daily safety call-ins and greatly helped with the camp logistics.

B-019: Phytoplankton ecology. Project leader: Oscar Schofield. Field Team personnel: Michael Garzio (MS Student), Bethan Jones (Postdoc), Travis Miles (Tech), Grace Saba (Postdoc), Marie Seguret (Postdoc).

Photo: Rutgers Webb-Slocum Glider recovery near Avian Island 21 January 2011. Credit: Grace Saba, B-019.

The phytoplankton component continues its time series measurements as part of the LTER summer cruise series. Phytoplankton productivity has increased dramatically as we preced south. The high productivity rates have been mirrored with extremely high phytoplankton biomass, most often exhibiting a subsurface peak at around 15 meters. The peak chlorophylls have occasionally reached almost 50 mg chlorophyll a m^{-3}. The ship surveys were complemented with glider data, which expanded our sampling in areas not occupied by the ship. The glider data also showed extremely high phytoplankton biomass. But also similar to Palmer Station, there were regions where the Colored Dissolved Organic Matter (CDOM) showed patterns that were distinctly different then the phytoplankton, indicating that we had several distinct water masses within our Process Station Grid.

We have also begun a large CO2 enrichment to assess how polar microbial communities will respond to high CO2 in the waters. Anthropogenic emissions since the 1800s have driven the rapid 40% increase in atmospheric carbon dioxide (CO_2), from preindustrial levels of 280 ppm to current levels of nearly 384 ppm. Nearly one third of anthropogenic fossil fuel CO_2 emissions is absorbed by the oceans, and the Southern Ocean, in particular, exerts a disproportionately large influence on the global marine carbon cycle and plays an important role in regulating atmospheric CO_2 concentrations. much emphasis regarding ocean acidification has been placed on marine algae, we know little about the effects of increased CO_2 on viral, bacterial, and zooplankton communities and rate processes, which profoundly influence food webs and biogeochemical cycles. Therefore, it is critical to understand the possible responses of plankton communities to future projections of global climate change.

We are conducting a semi-continuous mesocosm experiment using a natural plankton assemblage collected from Marguerite Bay (Process Study II). Sets of triplicate mesocosms (20L carboys) are being bubbled with pCO_2/air mixtures (custom-mixed by Linde/SpectraGas) at glacial atmospheric minimum CO_2 levels (180 ppm), current CO_2 levels (385 ppm), and a doubling of current CO_2 levels (750 ppm). Mesocosm incubations will be carried out for 15 days at in situ light and temperature with samples collected intermittently throughout the incubation period. From these experiments, we will determine how increased CO_2 affects: 1) virus, bacteria, phytoplankton, and zooplankton biomass and community structure, 2) rates of algal primary production and nitrogen uptake and incorporation, 3) phytoplankton carbon fixation enzyme activity (RuBisCO and PEPC activity), 4) viral infection frequency, and 5) rates of bacterial production. This experiment is supplemented with two similar mesocosm experiments at Palmer Station this season (one completed, one scheduled for late February). Additionally, Antarctic krill, the major food source for penguins and whales in the Southern Ocean, have been incubated with natural plankton assemblages acclimated to variable CO_2 concentrations to determine effects of increased CO_2 on krill metabolism, including feeding and nutrient excretion rates and changes in metabolic enzymes. This mescosm effort has attracted several collaborators, which include Dr. Hugh Ducklow (Marine Biological Laboratory), Dr. Lee Kerkhof (Rutgers University), Dr. John Reinfelder (Rutgers University), Dr. Alex Culley (University of Hawaii), Dr. Deborah Steinberg (Virginia Institute of Marine Science), and Dr. Debora Iglesias-Rodriguez (University of Southampton, UK).

B-020. Zooplankton Component. Project Leader: Deb Steinberg. Field Team personnel: Joe Cope (Chief Tech), Kate Ruck (M.S. student), Caitlin Smoot (undergraduate intern), Kim Bernard (post-doc), Lori Price (M.S. student).

This week we finished full stations on the LTER 200 line and concentrated our operations in the Process-2 (P2) study region near Adelaide Island in the Adèlie penguin foraging area. We did intensive net towing and Biosonics acoustics monitoring in the foraging areas shown in the figure above. Our aim was to characterize the zooplankton prey field in the penguin foraging region. The Acoustics towfish was deployed simultaneously with the nets and between stations, and paired macrozooplankton tows from each station were sorted on board. At the “main” Process-2 study station and at station 9 we performed depth-stratified tows using the MOCNESS. We also did some deep towing for another potentially important penguin prey- the Antarctic Silverfish (*Pleuragramma*).

The prey field was variable, ranging from stations with mostly juvenile *Euphausia superba* (P2 stations main, 2, &5) or other euphausiids to mostly salps and *Limacina* pteropods (P2 stations 6-9). There were very few adult *E. superba* in any of the tows. The acoustics did seem to pick up a layer of juvenile krill between 60-80 m at P2 station 2. We did catch Silverfish at a few stations as well (200.040 and the main P2 station). The minimal *E. superba* adult prey we saw in the field appeared to be reflected in the penguin diet samples from Avian Island that have been sorted thus far; the diet mostly consisting of juvenile *E. superba or Thysanoessa macrura* euphausiids, or fish.

We also continued to measure grazing and fecal pellet flux at selected stations, and collaborated on a krill CO_2 experiment with B-019 (see B-019 summary). We performed our third dilution experiment to measure microzooplankton grazing at P2 the "main" station, and took samples for zooplankton lipid and gut fluorescence analyses. We performed fecal pellet production experiments with salps (station 200.160) and juvenile *Euphausia superba* (P2 main station). Gut evacuation rate (GER) experiments were also performed with juvenile *Euphausia superba* at the P2 main station, and with *Limacina* pteropods (the latter were so abundant near Avian island that we were able to gently hand-collect them from zodiacs!). The GER results will be used in conjunction with the gut fluorescence measurements to determine macrozooplankton community grazing rates.

B-045: Microbial biogeochemistry. Project leader: Hugh Ducklow. Field Team personnel: Matthew Erickson (Chief Tech), Zena Cardman (Volunteer), Will Daniels (Volunteer), Kuan Huang, (PhD student), Kenneth Legg (Volunteer).

B-045 continued to investigate distributions of microbial plankton and selected biogeochemical properties and measure bacterial production rates. Bacterial production was about 3 times higher in the Marguerite Bay region than last year (77 vs 24 mgC/m2/day, 0-50 meters), possibly reflecting high SST in the area (1.5 to 3.5C). In general we are seeing high bacterial production rates this year, relative to observations since 2003, including the some of the highest discrete depth leucine incorporation rates we have measured in the WAP region (>100 pmol/l/hr).

B-114: Ecological Physiology of Marine Crenarchaeota Populations from the WAP. J.T. Hollibaugh, University of Georgia and Lihini Aluwihare, Scripps Institution of Oceanography.

To date we have collected samples for qPCR, RT-qPCR, biogenic silica, and CRD-FISH enumeration of crenarchaeotes from 36 station/depth combinations and run ammonia oxidation rate assays and collected nutrient samples at 25 station/depth combinations. Generally we collect 2 samples per station, one at the temperature minimum in the Winter Water and one at 400 m in the CDW. We have also completed sampling for the first Process Station and are in the midst of sampling for the second. At these process stations additional samples were collected for metatranscriptomics and for single amplified genomes. At process station 1 we were also able to filter over 3000 liters from the depth of the Winter Water layer using our McLane pumps. Additional large volume filtration was also conducted within the core of the CDW. The suspended POM isolated from these water masses will be used for crenarchaeal and bacterial lipid characterization and del 13C analyses. At these depths we also conducted ammonia oxidation assays using a variety of substrates including some organic compounds. Large volume

dark incubations were also run with 13C-labelled bicarbonate to monitor potential bicarbonate uptake by crenarchaeal populations in Winter Water and Circumpolar Deep Water environments.

We have also examined the time course of ammonia oxidation at one station and set up assays to measure ammonia oxidation rates on shallow water benthic biofilms sampled at various locations. Another group (Ducklow, B-045) observed a peak in abundance of a small (<0.6 um) pigmented cell at one of the stations we sampled. In addition to the microbial community composition and metabolism studies we are also isolating DOC from the CDW for chemical and isotopic characterization.