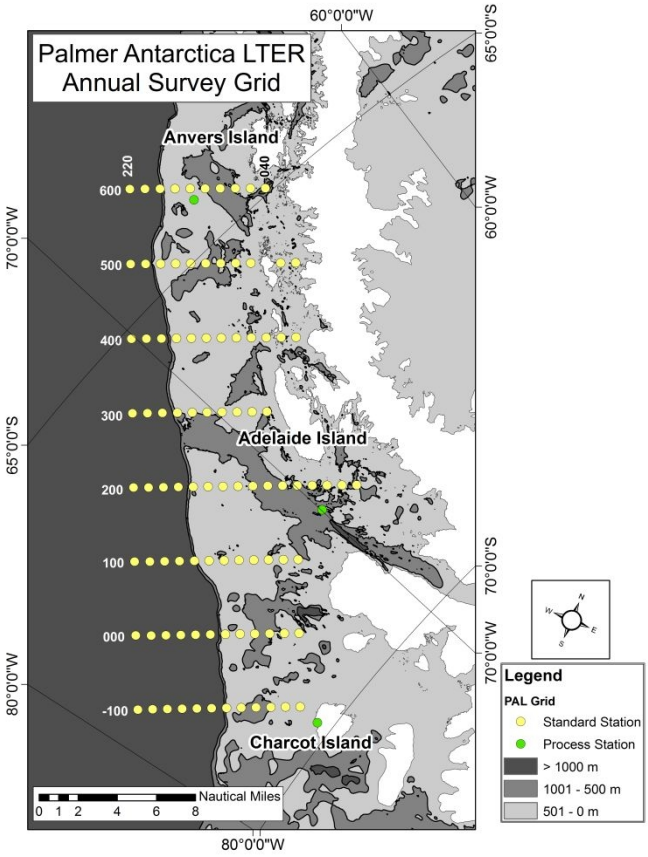
Weekly Update 1: LMG Cruise 11-01 Palmer LTER
07 January, 2011



LM GOULD departed Punta Arenas just after midnight 02 January after a blizzard in the northeastern US delayed several cruise personnel by 3 days. By that time ECO, AGUNSA and RPSC had the vessel loaded, organized and secured for a quick passage to Palmer Station. We enjoyed a nearly mirror-smooth crossing due south to Palmer Station. After a brief port call at Palmer, we departed on 07 January to commence the 19th LTER summer cruise. Once again Palmer Station was a gracious and efficient host to help get us on our way.

Palmer LTER is in the middle of its fourth six-year funding cycle with support from the NSF Antarctic Research Division's Organisms and Ecosystems Program. The overall aim of Palmer LTER is to gain a comprehensive, mechanistic understanding of the coupled ecological, biogeochemical and geophysical dynamics of the marine ecosystem along the western Antarctic Peninsula (WAP). The current grant is titled "Looking Back in Time Through Marine Ecosystem Space." Our guiding hypothesis is that there is a north-south climate-ecological gradient along the Peninsula that we can exploit to determine how the ecosystem has responded over recent decades to climate variability and change. Over the next 28 days we will survey a 700 x 200 km region along the WAP from Anvers to Charcot Islands, making CTD casts and collecting water bottle and zooplankton net samples at discrete hydrographic stations (map).

Much of our research on this year's cruise is being coordinated with the ASPIRE (Amundsen Sea International Research Expedition) currently aboard the NB PALMER in the Amundsen Sea Polynya.

Individual reports from the LTER component and guest projects follow.

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

The port call at Palmer Station in prep for LTER 1101 was efficient and productive. Both Palmer Logistics and LMG Marine helped us to load our gear for the Avian Island field camp in the hold and organize space in the lab for our work over the next month. For this cruise, we plan to

conduct at-sea observations of seabirds and marine mammals through 30-min transect and 15-min stationary surveys along major transect lines, as well as 30-min stationary surveys during process studies.

Furthermore, we plan to continue with our annual field camp at Avian Island where we will focus the breeding and foraging ecology of Adelie penguins. We also plan to conduct similar fieldwork at Charcot Island and Prospect Point.

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).

The phytoplankton component of the LTER will continue to build the time series for phytoplankton composition, productivity, and trace metal measurements. This will be complemented with a full suite of bio-optical measurements, which were added to the LTER sampling in 2008. The bio-optical measurements consist of spectral irradiance, absorption, attenuation and backscatter. We also will continue to contribute a glider to the cruise efforts. This will be especially notable during the first process station of the cruise at the Palmer Deep study site (Grid Station 600.040). Cruise measurements will also be complemented by a robotic fleet being launched from Palmer station. The Palmer deep study area will be surveyed by 4 gliders and 2 AUVs (Hydroid REMUS systems), which make it the largest ocean robotic effort to date in Antarctica. The robotic network will adaptively sample the Palmer deep area based on real-time data collected by the ship and by the satellite. The coordinated activity of the glider fleet (outfitted with an ADCP, FIRE fluorometers, CTD, and EcoPucks) will be guided by real-time telemetry provided by foraging penguins outfitted with satellite tags. The coordinated activity of the gliders will be conducted by senior undergraduates and a glider technician from Rutgers via the Iridium network.

Finally we also conduct a CO2 manipulation experiment to understand phytoplankton responses to a high CO2 world and ocean acidification. The experiment, designed in collaboration with the University of Southampton, will incubate natural samples at past, present day, and future CO2 conditions. We will utilize pre-mixed CO2 gas for the effort and measure the biogeochemical responses of the manipulated populations.

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).

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 continue to emphasize the role that zooplankton play in the biological pump (grazing, fecal pellet production, and diel vertical migration). We will also be sampling the grid as in past years for meso- and macrozooplankton abundance and species composition. We will be ‘ground-truthing’ the acoustic glider with net tows and an acoustic towfish during our surveys of deep-canyon penguin

feeding grounds (part of Dr. Bernard's project). Graduate student thesis projects we will be sampling for include microzooplankton community composition and grazing along the LTER grid (L. Price) and lipid composition of krill and other zooplankton to determine changes in food quality for higher predators down the peninsula (K. Ruck).

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).

The goal of B-045 is to understand the cycling of carbon in the WAP ecosystem. We will collect samples for analysis of microbial abundance (both heterotrophic bacteria and nanophytoplankton), heterotrophic bacterial production and growth rates, dissolved organic and inorganic carbon concentrations, dissolved oxygen concentration and oxygen isotopic composition (Princeton grad student K. Huang), inorganic nutrients and particulate organic matter. We will employ flow cytometry to measure autotrophic and heterotrophic nano- and picoplankton populations and community structure and determine net population growth rates of selected groups.

The oxygen isotope data are used to estimate gross primary production and net community production, for comparison with the measurements by the phytoplankton group and export to the sediment trap. We will recover the moored time-series sediment trap and deploy it for another year to collect sinking particles and estimate the export of carbon from the upper water column.

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

Ammonia oxidation is the first step in the conversion of regenerated nitrogen to dinitrogen gas via denitrification, a 3-step pathway mediated by 3 distinct guilds of bacteria and archaea. Our previous work on Ammonia Oxidizing Archaea (AOA) in the Palmer LTER study area West of the Antarctic Peninsula (WAP), has suggested strong vertical segregation of crenarchaeote metabolism, with the "winter water" (WW, ~50-100 m depth range) dominated by non-AOA crenarchaeotes, while Crenarchaeota populations in the "circumpolar deep water" (CDW), which lies immediately below the winter water (150-3500 m), are dominated by AOA. These findings led to 2 major hypotheses that will be tested on this cruise: 1) the WW population of Crenarchaeota in the WAP is dominated by heterotrophs; 2) the WW population of Crenarchaeota in the WAP "grows in" during spring and summer after the WW water mass forms. Further implications of these hypotheses are a) that nitrification rates should be low in WW samples; b) uptake and oxidation of organic carbon should be high there, possibly resulting in release of ammonia; c) WW crenarchaeote biomass should be composed of carbon supplied as phytodetritus, while autotrophic CDW should be composed of carbon from the deepwater DIC pool.

We hope to sample the WW and CDW at each of the stations on the LTER grid. We will use these samples to measure the relative abundance and phylogenetic composition of the crenarchaeote population by quantifying 16S rRNA genes. We will also survey the distribution

of representative functional genes that are key to autotrophic ammonia oxidizers. Comparisons of gene versus transcript abundance will let us identify active verses quiescent populations of AOA. These indirect assessments of autotrophy versus heterotrophy will be tested further by measuring ammonia oxidation rates using 15N ammonium and carbon fixation rates using 13C bicarbonate. Nutrient, including ammonia, analyses will put these results in an environmental context.

Analysis of metatranscriptomic samples taken at process stations will provide a functional characterization of active organisms that is not constrained by primer bias. We will also collect samples for analysis of microbial membrane lipid chemical and stable isotope composition at process stations. In particular we will isolate both bacterial hopanepolyols and archaeal glycerol dialkyl glycerol tetraethers from WW and CDW microbial populations. We will then compare composition and stable carbon isotope signatures between depths and between Archaea and Bacteria. Samples will also be taken for subsequent single-cell genomic characterizations of representatives of WW vs CDW Crenarchaeota populations. Uptake and assimilation by crenarchaeotes of heterotrophic substrates (primarily amino acids) on a cell-specific basis will provide us with yet another way of assessing the changes in metabolism with depth in the WAP, these experiments will also allow us to determine the fraction of organic nitrogen that is oxidized versus released as ammonium.

Ammonia oxidation and the overall process of nitrification-denitrification have received relatively little attention in polar oceans where the effects of climate change on biogeochemical rates are likely to be pronounced. In particular, there are few measurements of ammonia oxidation rates. Our work will provide insights into the ecology and physiology of AOA and the knowledge needed to model how water column nitrification will respond to changes in polar ecosystems accompanying global climate change.