PALMER STATION MONTHLY SCIENCE REPORT

December 2012

Dr. Oscar Schofield's group (B-019-P) begin glider deployments from Palmer Station. The autonomous Slocum gliders are outfitted with a variety of sensors that allow the group to study physical oceanography and the phytoplankton in the Palmer Deep canyon *(image credit: Elizabeth Asher)***.**

NEWS FROM THE LAB
By Carolyn Lipke, Assistant Supervisor of Laboratory Operations

The month of December brought many visitors to Palmer Station. At the beginning of the month we welcomed Deborah Steinberg's group (B-020), which was well-timed with the arrival of krill and whales. We then had visits from the *M/S National Geographic Explorer* and two private yachts. The *M/V Le Boreal* came to visit, carrying the Climate Change Challenge group led by Jim McClintock (B-027) who presented the Palmer Station LTER with the gift of a webcam that will be installed on Torgersen Island. The Chilean Navy stopped by, and the *H.M.S. Protector* dropped in to do an Antarctic Treaty Inspection. The inspection went well, and Palmer Station residents were invited out for a tour of their ship.

The first penguin chicks and the unprecedented streak of nice weather brought an influx of energy to station. This month ASC staff also hosted a Palmer Station Science Fair. Contract staff had a chance to do some science experiments of their own, and exhibits included a home-made twig burning gas stove, a pinhole camera, and of course a baking soda volcano.

Reide Corbett's group (O-176) arrived just in time to celebrate the winter holidays. There was a polar plunge on Solstice, and a wonderful feast and gift exchange for Christmas. Most gifts were hand-made, and revealed the many talents of Palmer Station's residents.

The year of 2012 was a good year for Palmer Station, with over 26 science groups occupying the Bio and Terra Labs. We wish you all a very happy and productive 2013.

DECEMBER 2012 WEATHER
By Glenn Grant, Research Associate

Dry weather and clear, calm days made December 2012 a remarkable month. Total melted precipitation was only 2.3 mm; in contrast, the 24-year average for melted precipitation in December is 37.9 mm. Measured snowfall was just 1 cm. Even so, snowstake accumulation lingered longer into the year than usual, starting the month at 67 cm and then melting quickly until bare ground was exposed on the 20th. At the end of the month patches of deep snow drifts still remained in shadowed areas, melting rapidly.

The average temperature for the month was 0.9° C, near the historical average of 1.3° C. The minimum temperature was -4.4° C, with the maximum a balmy 6.2° C (43° F). The atmospheric pressure was especially high during the last two weeks of December, peaking at 1009.4 mb. With the high barometric pressures came light winds: The average wind speed was 6 knots, with a peak gust of 35 knots on the 15th. Overall, December was mild, warm, and often sunny.

Sea ice conditions changed rapidly at the beginning of the month. Sea surface temperatures rose above freezing and quickly melted any remaining floes, leaving only bergy bits and brash ice from glacier calvings. Meanwhile, an armada of larger ice bergs moved into the Bismark Strait southwest of Palmer Station, giving us a spectacular display across the horizon. By the middle of the month, however, most of the bergs had moved away, leaving behind only a few small ones grounded locally plus a couple of large tabular bergs lurking in the distance. Despite the relatively warm ocean and sunny days, a soccer-field-sized slab of sea ice remained at the very back of Hero Inlet, melting slowly until finally disappearing around Christmas.

For all of 2012, the total melted precipitation was 361.6 mm. To put this in perspective, the historical average yearly precipitation is almost twice as much, 644.9 mm, although there are large variations between years. Cumulative snowfall for the year was 294 cm, somewhat closer to the yearly average of 345 cm.

B-003-P THE SEASONAL DYNAMICS OF CO2, PRIMARY PRODUCTION, AND DMS IN THE WESTERN ANTARCTIC PENINSULA: MEASUREMENTS OF POOLS AND PROCESSES USING MASS SPECTROMETRY

Dr. Francois Morel, Principal Investigator, Princeton University; Dr. Philippe Tortell, Co-PI, University of British Columbia; Dr. John Dacey, Co-PI, Woods Hole Oceanographic Institution

Personnel on Station: Elizabeth Asher, Sven Kranz, and Jodi Young

Over the past month we established a good sampling schedule to meet our first objective; describing the seasonal cycles of carbon uptake, photosynthesis, and biogenic dissolved gasses in near-shore surface waters of the WAP region. We sample twice per week from 10 m depth at station B with a submersible monsoon pump and Go-Flo bottles, collecting one hundred liters on average. This collection is timed to coincide with the long-term ecological research (LTER) program at Palmer Station. From our samples we explore two main areas; (1) the cycling of dissolved and total dimethyl sulfide (DMS) and its precursor compounds, dimethyl sulfoniopropionate (DMSP) and dimethyl sulfoxide (DMSO) and (2) phytoplankton community and physiology, with a particulate emphasis on carbon fixation.

Research theme 1: Concentrations of dissolved and total dimethyl sulfide (DMS) and its precursors

To study the cycling of DMS and its precursor compounds over the season, we measured the concentrations of DMS, DMSO and DMSP, as well as the rates of loss and accrual of DMS. Modest DMS concentrations (≤ 5 nM) persisted throughout October, giving way to higher DMS concentrations of ~10nM by mid December at Station B (Fig. 1).

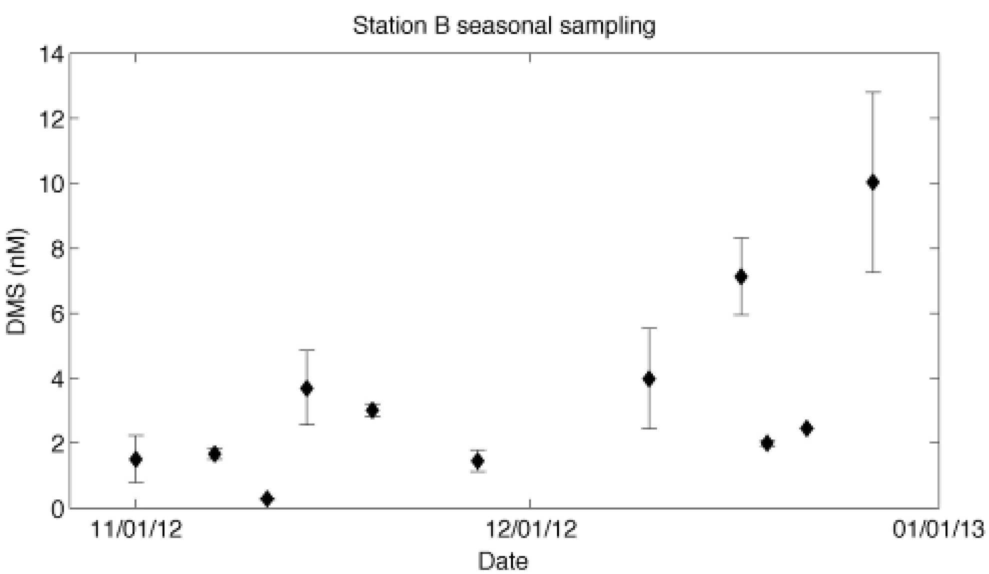


Figure 1: Seasonal concentrations of DMS. Error bars represent the standard deviation of quadruplicate samples.

The microbial production and consumption rate of these compounds were measured using six hour long incubation experiments with stable isotope tracers once per week and with competitive inhibitors for DMS (a stable isotope labeled form of DMS) and for DMSP (glycine betaine) once per week, respectively. For tracer experiments, stable isotope tracers, each with a different mass to charge signature, are added to four replicate gas tight bags that incubate at in situ temperature and light conditions. The accrual and loss of these stable isotopes designate changes in the DMS, DMSP, and DMSO pools respectively. On other sampling days, competitive inhibitors for DMSP and DMS are added in large excess to prevent the loss of DMS and DMSP, yielding measurements of gross production of DMSP and DMS (Fig. 2). The gross consumption of DMS and DMSP is calculated by comparing these competitive inhibition treatments to natural seawater DMS and DMSP concentrations during the incubation (Fig. 2). Rate constants are calculated by changes in the log of DMS concentrations, and DMS production from these sources is the product of rate constants and the natural DMS concentrations.

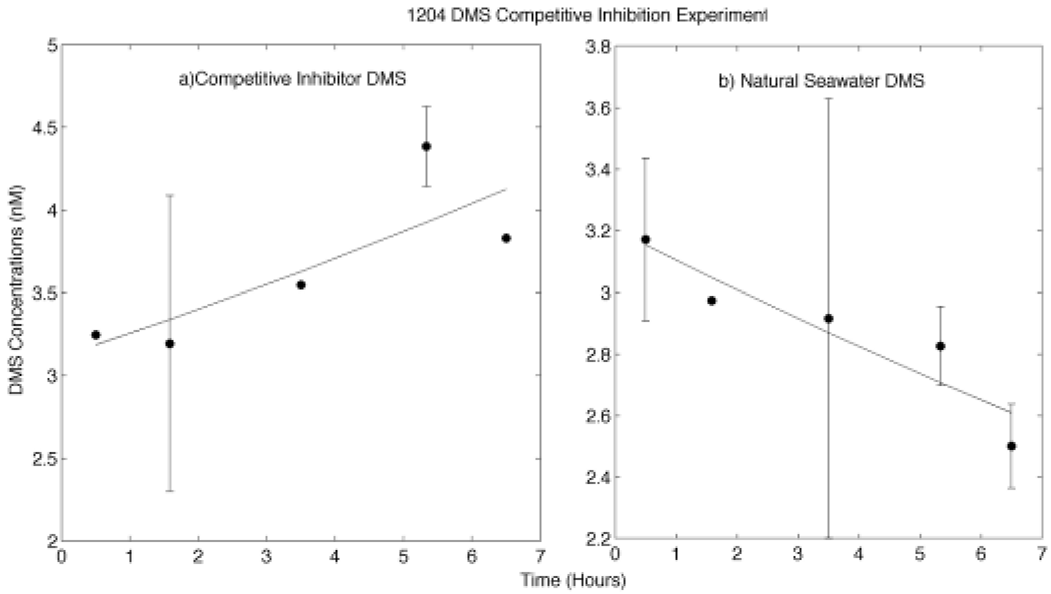


Figure 2: A time course experiment showing the natural DMS concentrations with the mass to charge ratio of 62 in a) competitive inhibitor DMS treatments and b) unamended, natural seawater DMS treatments. Error bars represent the range of duplicate samples.

We continue to measure dissolved gas concentrations of oxygen, argon, and carbon dioxide (pCO_2) our membrane inlet mass spectrometer (MIMS) from the pump house intake in the aquarium room as part of our seasonal sampling plan (Fig. 3). These measurements have exhibited a net increase in biologically produced oxygen, measured as the ratio of oxygen to argon (O_2/Ar), and a sharp drawdown of pCO_2, yielding some of the worlds highest O_2/Ar and lowest pCO_2 ever recorded. Daily variations or "diel" cycling in these biogenic gasses is well correlated with variable fluorescence (Fv/Fm), a measure of phytoplankton physiological health. The Fv/Fm data were collected by project B-466-P (PIs, Deneb Karentz and Joe Grzymski). After an exceptional period of productivity through mid-Nov. to early December, our gas measurements, coupled with Fv/Fm data indicate a collapse of the plankton bloom and a rest of the surface waters to atmospheric equilibrium. Current pCO_2 and O_2/Ar are similar to levels witnessed in October, and we are anticipating a secondary peak in productivity.

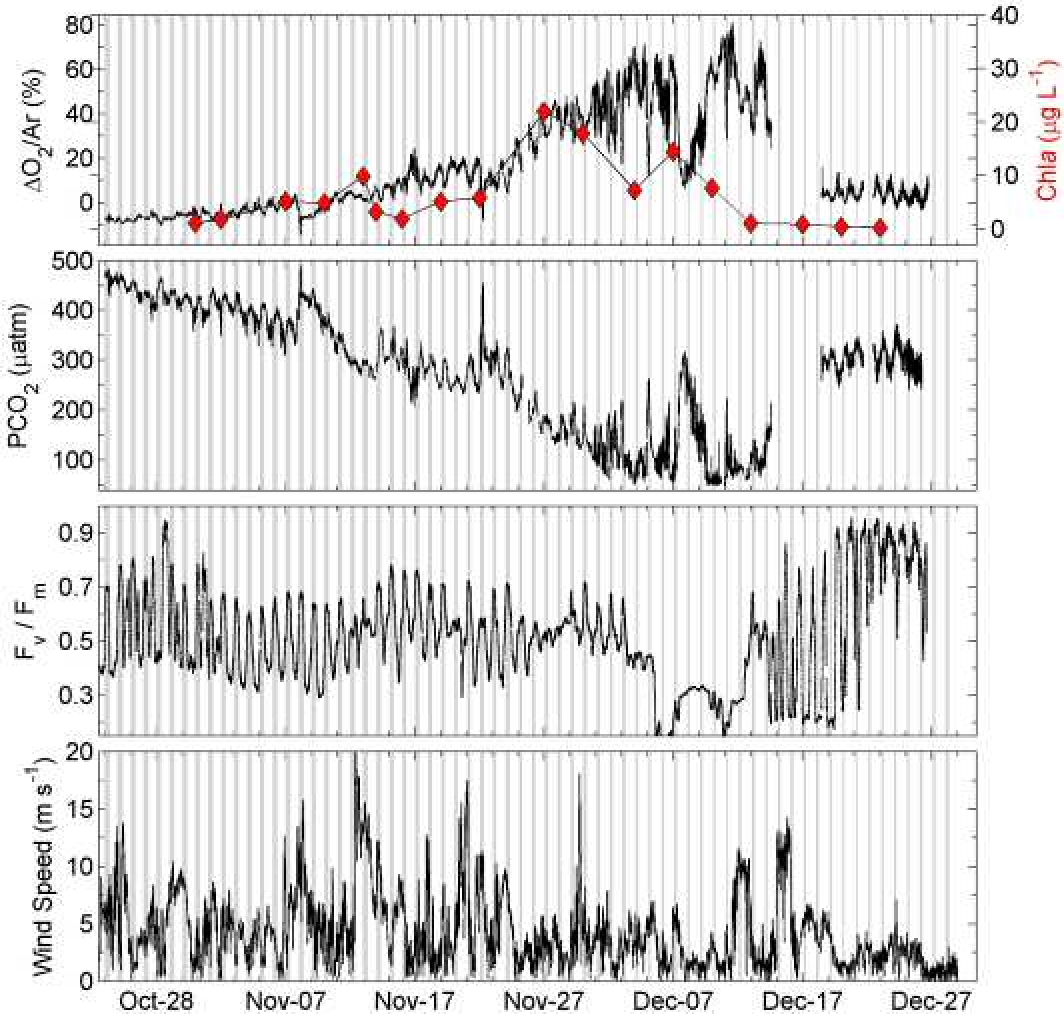


Figure 3 Membrane inlet mass spectrometry acquired pCO_2 and O2/Ar from the pump house intake. Biogenic gas concentrations are paired with chlorophyll (in red in the top panel), fv/fm (in the second panel), and wind speed measurements (in the bottom panel) to show correlations between gasses, phytoplankton biomass, and wind mixing events. Fv/Fm data are provide courtesy of Joe Grzymski and Deneb Karentz (B-466-P)

In addition to our seasonal sampling protocol, we have conducted two micro-zooplankton dilution experiments to determine both grazing rates and the effects of grazing on DMS production in collaboration with fellow Palmer station scientist, Mike Stukel. Initial results from December 22 show noticeable grazing rates on phytoplankton (and DMSO and DMSP producers), a well as a net positive increase in DMS production due to grazing (Fig. 4). By adding a competitive inhibitor to two of the incubation bottles with whole seawater (i.e. not diluted with 0.2 micron filtered seawater), we calculated the overall DMS production over the 24-hour period as 4.69 ± 1.38 nM, forty percent of which was attributed to micro grazing. We have made measurements along a transect (the first of two on December 9th) spanning ~4.4km from station E to station A to determine the spatial gradient of DMS concentrations within our boating area, and determine the potential changes in DMS due to lateral advection. Concentrations in DMS ranged from 4.3-21 nM, averaging 9.0 nM with a standard deviation of 6.4 nM.

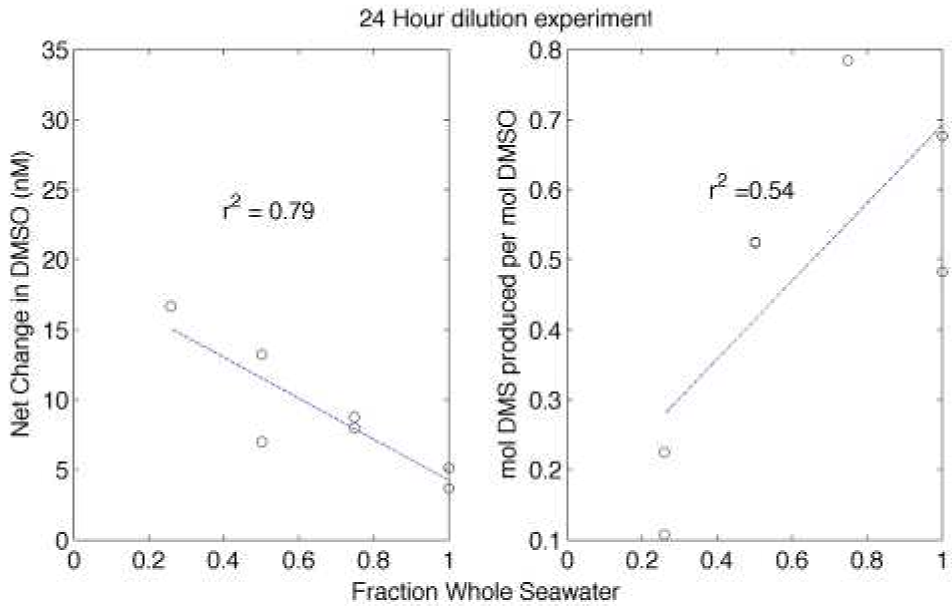


Figure 4. A 24-hour dilution experiment from December 22 showing grazing on DMSO producers and a positive relationship between DMS production and grazing on phytoplankton. On the x-axis, the dilution ranges from 0 (all 0.2 micron filtered seawater) to 1 (all natural seawater).

Research Theme 2: Phytoplankton community and physiology, with a particulate emphasis on carbon fixation.

Throughout December we continued to monitor the surface ocean inorganic carbonate parameters (total alkalinity, pH, dissolved inorganic carbon) along with the phytoplankton community and physiology at station B. Parameters measured included primary productivity, chlorophyll concentrations, bacterial productivity, flow cytometry, pigments, particulate organic carbon, variable chl fluorescence (Fv/Fm) and carbon fixation parameters (bicarbonate use, affinity for CO_2, carbonic anhydrase activity). The start of December saw the end of a large diatom bloom. Chlorophyll concentrations that were as high as 45 µg/L on 30 November decreased quickly into December and remained low through the rest of the month (Figure 5).

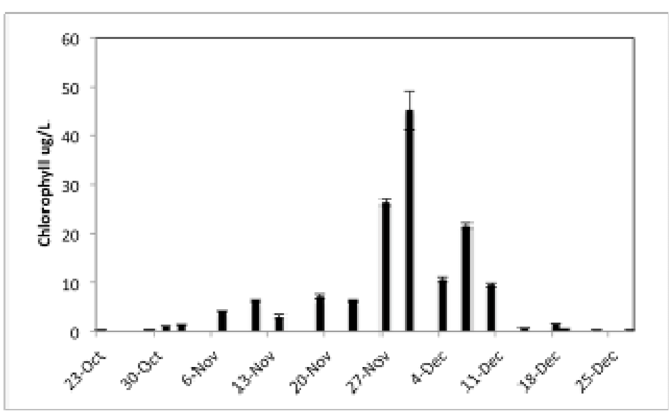


Figure 5: Seasonal concentrations of chlorophyll at 10m at Station B.

At the beginning of December we harvested our second longer-term (two to three week) incubations. The aim of these incubations is to assess the response of the natural phytoplankton community to CO_2 perturbations (bubbled at CO_2 concentrations of 100, 400 and 800 ppm) (**Fig. 6**). At the end of the first and third dilution, we measure the same suite of chemical and biological parameters as during the seasonal sampling.

Figure 6: Experimental setup to acclimate phytoplankton to different CO_2 concentrations. The gas-cylinders are connected to the incubation bottles filled with seawater. The screening blocks roughly 50-60% of sunlight mimicking a water depth of 5-10m.

We found that different CO_2 concentrations had little effect on total phytoplankton biomass (using chlorophyll as a proxy for biomass, **Figure 7A**). However, we did see changes in phytoplankton physiology. Carbon fixation by the phytoplankton community decreased as CO_2 concentrations increased (**Figure 7B**). In addition, their affinity for CO_2 (expressed as the half saturation constant for CO_2, K_m) decreased and their bicarbonate use increased as CO_2 concentrations increased (**Figure 7C and 7D**).

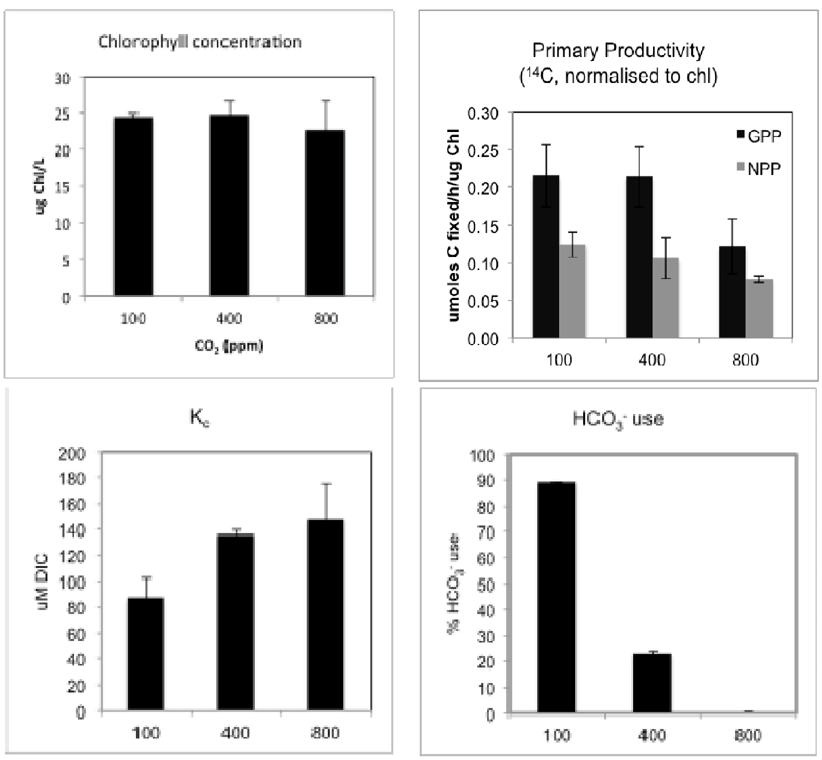


Figure 7: Phytoplankton community response to different CO_2 concentrations A. chlorophyll concentrations B. Primary productivity (net and gross) C. Affinity for CO_2, shown by the half saturation coefficient of CO_2 and D. Percentage of carbon fixed that comes from bicarbonate. 100, 400 and 800 correspond to CO_2 concentrations in ppm.

B-013-P PALMER LONG TERM ECOLOGICAL RESEARCH (LTER): LOOKING BACK IN TIME THROUGH MARINE ECOSYSTEM SPACE, APEX PREDATOR COMPONENT

Dr. William R. Fraser, Principal Investigator, Polar Oceans Research Group, Sheridan, MT

Personnel on station: Shawn Farry, Ben Cook, and Jennifer Mannas

The weather at Palmer Station was near perfect during December with no days of field work lost to high winds or ice. We were able to continue monitoring breeding chronology of selected Adélie penguin nests on Humble and Torgersen Islands and maintain regular censuses of the local Adélie colonies. The good weather also allowed regular visits to both Dream and Biscoe Islands to continue penguin and skua studies.

A peak egg census was completed at the beginning of the month for chinstrap penguins on Dream Island and for gentoo penguins on Biscoe Island. Preparations for the Humble Island Adélie penguin radio transmitter project continued; equipment was installed on Humble Island and data collection/transfer was tested. Due to a slight delay in breeding this season deployment of satellite transmitters and dive depth recorders on Adélie and gentoo penguins has been delayed until early January.

Skua work continued this month as we began checking nests for newly hatched brown skua chicks on local islands as well as on Dream and Biscoe Islands. Our south polar skua mark-recapture and breeding monitoring study on Shortcut Island continued with nest initiation checks, band resighting, and scat collection. Our censuses of the Blue-eyed shag colony on Cormorant Island continued with the first chicks of the season observed in early December. A kelp gull survey was completed mid-month on all local kelp gull colonies as well as on Dream Island. Foraging ecology studies of giant petrels continued with satellite transmitter deployments at Kristie Cove as well as on Shortcut Island. Our all-island census of giant petrels began in early December; new nests were identified, new breeders were banded, and the census will continue into January.

Our monitoring of marine mammals continued this month with periodic sighting of humpback and minke whales as well as increasing numbers of molting elephant seals. Lab work has continued with the processing of skua scat and regurgitate samples as well as processing limpet samples from kelp gull colonies. LTER cruise preparations continued throughout the month. We also participated in the *M/S National Geographic Explorer* and *M/V Le Boreal* tour ship visits that occurred this month.

Thanks to ASC for their continued support this month. Special thanks to Julie Jackson for all the hard work maintaining our Birder boats and keeping us out on the water.

B-018-P: MOLECULAR ASSESSMENT OF PHYTOPLANKTON COMMUNITY DYNAMICS AND METABOLISM IN THE WEST ANTARCTIC PENINSULA

Dr. Shellie Bench, Principal Investigator, Stanford University, CA

Personnel on station: Shellie Bench (PI and Post-Doctoral Research Fellow)

As during November, sampling from zodiacs continued twice weekly on LTER sampling days, for the first two weeks of December. In the second half of the month the frequency was reduced to once weekly in preparation for my departing Palmer Station on December 20th and transferring sampling and processing responsibilities to members of other groups. For the next two months, Lizzy Asher and Jodi Young will collect water for my samples once per week from Station B on a LTER sampling day when they are also sampling for their own projects. For the remainder of the season, Mike Stukel will be primarily responsible for processing those water samples (filtering for microscopy and for DNA and RNA), and all laboratory supplies for sample processing were moved into his laboratory prior to my departure. I also prepared and packed supplies for the annual LTER cruise and provided a detailed inventory of those supplies to Mike Stukel and Carolyn Lipke. Finally, I arranged the samples collected during the last 2 months and the associated paperwork for shipping to Stanford so I can begin processing them in January for molecular analyses.

Based on microscopy observations, the volume of water that could be filtered and the color of the resulting filters, it appeared that the phytoplankton bloom that began at the end of November continued into the first week of December. Soon afterwards, I observed during sample filtration that the majority of biomass passed through the 3µm filter but clogged the 0.2µm filter, indicating a shift in the microbial community from larger phytoplankton to smaller phytoplankton and/or bacterioplankton. This rapid shift is precisely the type of microbial community change I hoped to capture with my sampling regime. The samples collected for DNA and RNA analyses should reveal important details about changes in microbial species composition and metabolic processes. And, as described in my original proposal, the suite of LTER data collected, especially that of the B-019 and B-045 groups, will provide critical contextual information to enable a biogeochemical interpretation of the molecular data.

The two collaborative projects described in the November report were carried out and will expand the use of molecular methods to sediment trap samples and incubation experiments. With the help of Mike Stukel, I collected and processed sediment trap samples to be used for DNA and RNA analyses. The trap was deployed at Station B from December 6th to 12th, which was immediately following the large phytoplankton bloom. As such, these samples could show which species are primarily responsible for the export of material from the surface into the sediments, as well as the metabolic processes occurring during such export. If the resulting nucleic acids are of sufficient quality, they could also be used in microarray experiments in future years. As my first attempt to collect and process sediment trap samples, some optimization of the protocol may be necessary, particularly after I determine the quality and quantity of nucleic acids that can be extracted. As such, reagents were prepared for another deployment that could be carried out as a comparison experiment or in case changes need to be made to the processing protocol.

The incubation experiment was carried out primarily by Lizzy Asher, with sample processing done under my direction and with much of my laboratory equipment. Lizzy incubated water samples from Station B with oxidized DMS compounds in gas-tight bags and measured their loss and the production of reduced DMS compounds over two weeks. Sub-samples were harvested and processed for DNA and RNA analyses that will help identify members the microbial community responsible for DMS metabolism as well as genes involved in these environmentally important metabolic processes. The training and equipment that I provided will enable Lizzy to repeat this experiment at least once more this season. In spring, she plans to visit my lab at Stanford where I can provide infrastructure and further training for nucleic acid extractions. I will also work closely with her to design and implement procedures for the subsequent molecular methods and analyses.

B-019-P PALMER LONG TERM ECOLOGICAL RESEARCH (LTER): LOOKING BACK IN TIME THROUGH MARINE ECOSYSTEM SPACE, PHYTOPLANKTON COMPONENT

Dr. Oscar Schofield, Principal Investigator, Rutgers University

Personnel on Station: Nicole Couto and Filipa Carvalho

December was a beautiful month at Palmer Station. Plenty of our sampling days were calm and full of sunshine. We continued with regular LTER sampling twice a week and, after the first week of the month, we noticed a significant decrease in chlorophyll concentrations and rates of primary productivity. These values remained low throughout the remainder of the month. A diurnal tide which began on November 26th coincided with the onset of the phytoplankton bloom we witnessed at the end of November and beginning of December, but the next diurnal tide which began on December 25th did not bring similar growth.

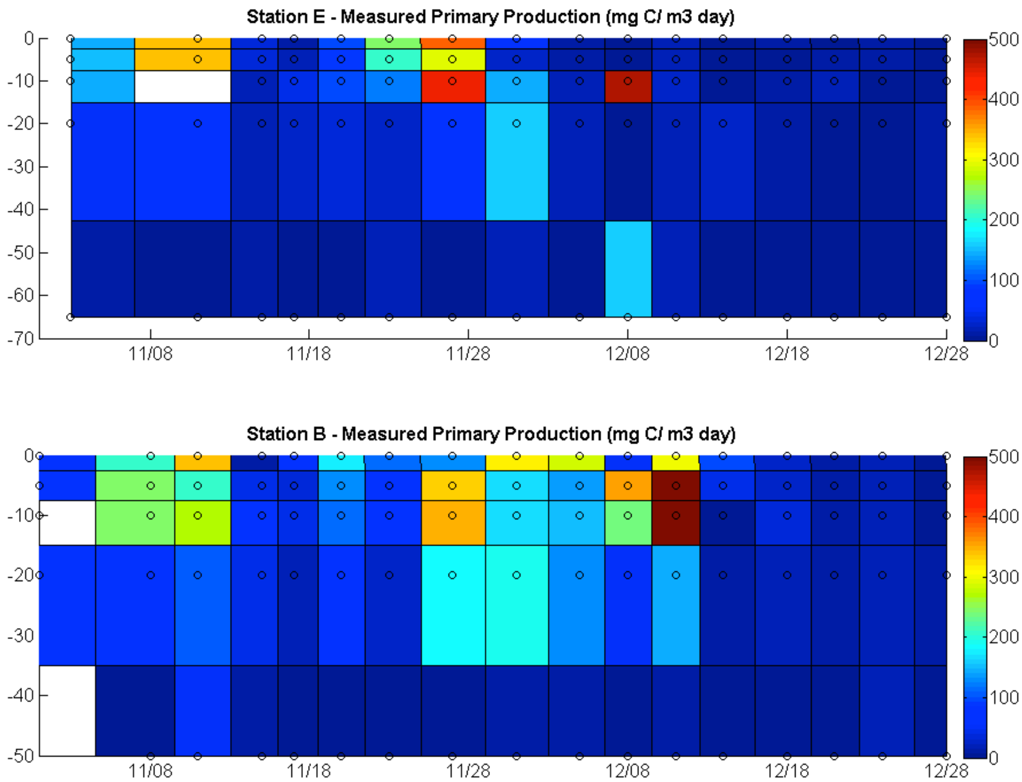
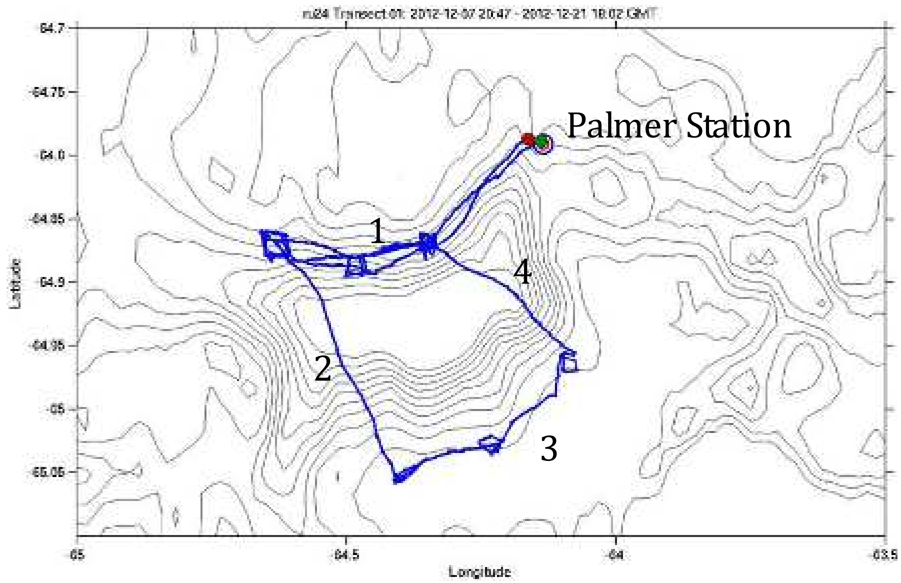


Fig. 1 Primary productivity at Stations E and B throughout the season. Primary productivity is measured at 0, 5, 10, 20, and 65 (50) m at Station E (B).

We also spent a lot of time in December preparing gliders for deployments. We deployed two shallow gliders for a tandem mission to survey the edges of the Palmer Deep canyon. One, RU24, was equipped with a FIRe sensor to measure variable fluorescence, a parameter that describes the quantity and health of phytoplankton. The other, RU06, was fitted with a current meter to study the flow of water in the canyon and relate that to the pattern of phytoplankton growth. Unfortunately, RU06 was damaged a couple days into the mission, most likely due to some animal encounter, and we lost the ability to control it and thus to collect the data we were after. But fortunately, both gliders were recovered and we hope to repeat the mission in January.



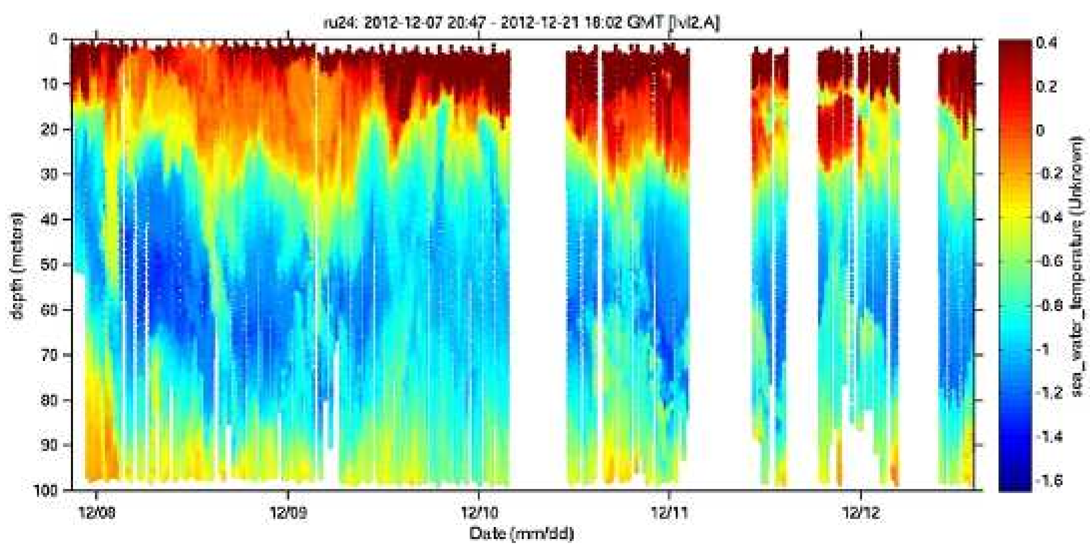


Fig. 2 (top) Track of RU24 from Palmer Station, around Palmer Deep, and back. **Fig 3 (bottom)** Temperature section from leg 1 of the RU24 mission.

A second pair of gliders was deployed in the middle of December. These two, RU25 and RU26 are capable of diving to 1000m and staying out for up to two months. They will both travel south along the historic LTER grid. RU25 will travel along several of the LTER grid lines out to the shelf and in towards the coast while RU26 will head straight towards Marguerite Trough where eddies are known to move towards the Peninsula. Its mission will be to find and stay within an eddy as it travels and dissipates heat.

B-020-P: PALMER LONG TERM ECOLOGICAL RESEARCH (LTER): LOOKING BACK IN TIME THROUGH MARINE ECOSYSTEM SPACE, ZOOPLANKTON COMPONENT.

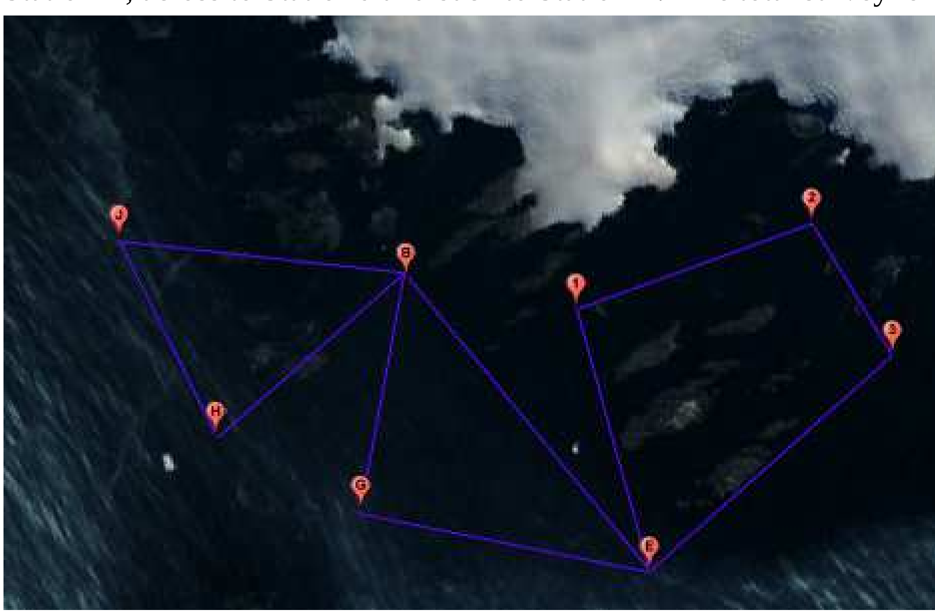
Dr. Deborah K. Steinberg, Principal Investigator, Virginia Institute of Marine Science, VA

Personnel on station: Kim Bernard and Dominique Paxton

We arrived at Palmer Station on December 2nd and began preparations for our field season on December 3rd. The zodiac, Ms Chippy, was ready for use within a week and we were able to calibrate and test the Biosonics DT-X echo sounder successfully. We started our official sampling on December 8th and conducted 9 acoustic surveys during the remaining 3 weeks of December.

This season we are focusing on the krill prey field in relation to top predator foraging activity. We are using acoustics to survey the krill distribution patterns, abundances and biomass and also to describe the aggregations that they form. We are conducting visual observations of top predators (including Adélie, Gentoo and chinstrap penguins; humpback and Minke whales; crabeater, leopard and fur seals; and Wilson's storm petrels and Antarctic terns) within a 50 m radius of the zodiac while we are running the acoustic transects. Visual observations are marked on a map in the field and later transferred into Google Earth to obtain position coordinates. Visual observations of predators foraging are then associated with nearby krill aggregations (within 500 m of each other) and we will later examine any relationships between krill aggregation parameters (e.g. depth, width, length, biomass, abundance, etc.) and top predator foraging behavior (e.g. foraging at surface, diving, bubble feeding, lunge feeding, etc.).
In addition to acoustic surveys, during diurnal tides when krill are nearer to the surface and more abundant, we conduct net tows to collect krill. We have been able to collect krill during the last two diurnal tidal cycles and have applied the measured length frequencies obtained to our acoustic data in order to estimate krill abundances.

Figure 1. Map of survey area. Acoustic transects are run from Station B to Station E, to points 1, 2 and 3 (also called K1, K2 and K3), back to E, across to Station G, back to Station B, out to Station H, across to Station J and back to Station B. The total survey length is 28 km.



B-045-P: PALMER, ANTARCTICA LONG-TERM ECOLOGICAL RESEARCH (LTER): CLIMATE MIGRATION, ECOSYSTEM RESPONSE AND TELECONNECTIONS IN AN ICE-DOMINATED ENVIRONMENT: MICROBIAL / BIOGEOCHEMICAL COMPONENT

Dr. Hugh Ducklow, Principal Investigator, The Ecosystems Center, Marine Biological Laboratories, Woods Hole, MA

Personnel on station: Sarah Laperriere and Stefanie Strebel

During the month of December, we sampled twice per week at both stations B and E with B-019. As part of the LTER, B-045 samples biweekly for bacterial productivity, bacterial and phytoplankton abundance, dissolved organic carbon, particulate organic carbon and nitrogen, and nutrients.

Mid-December brought a large spike in bacterial productivity and abundance followed by a sharp decline. Towards the end of the month, both bacterial productivity and abundance began to slowly increase again (Figure 1 and Figure 2).

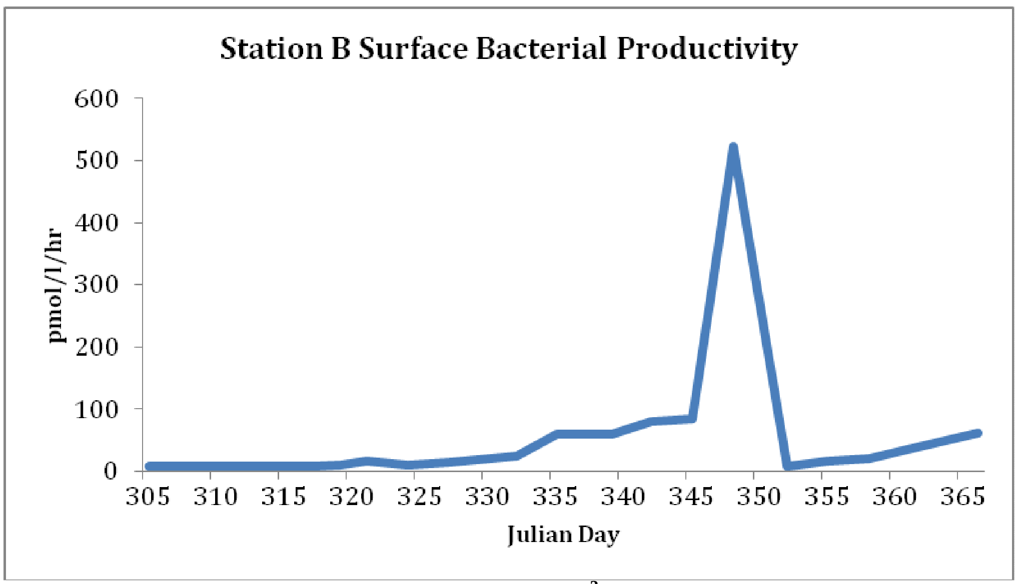


Figure 1. Bacterial production determined through ^{3}H-leucine incorporation, at Station B, from October 2012 to December 2012.

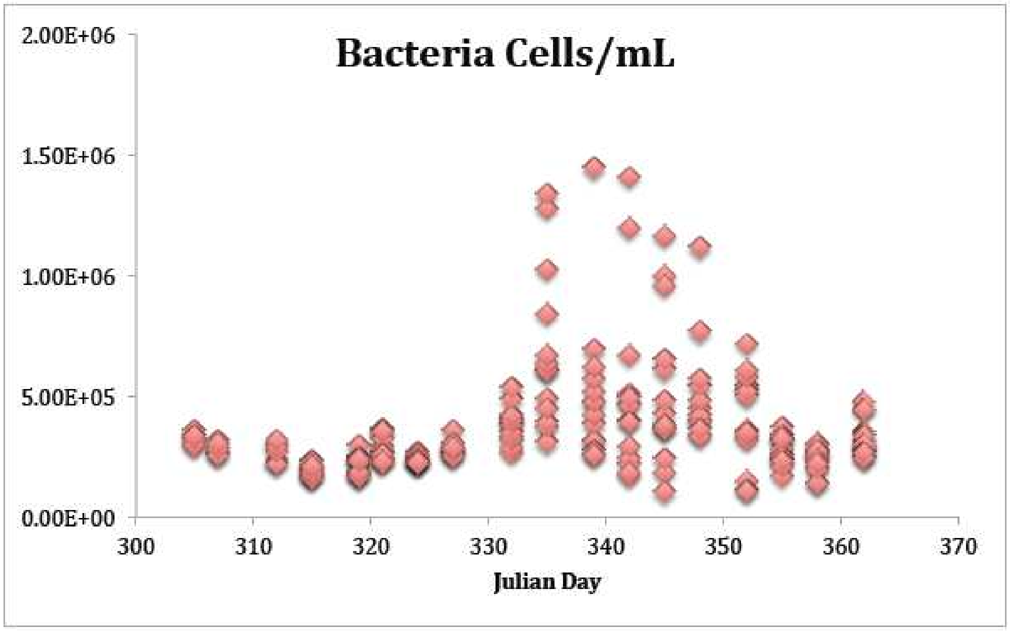


Figure 2. Bacterial abundance at Stations B (0 to 50m) and E (0 to 65m), from October 2012 through December 2012.

We also, with the help of B-020, conducted a krill incubation experiment to monitor the affect of krill on the bacterial community. Further research and experiments will be conducted in the future.

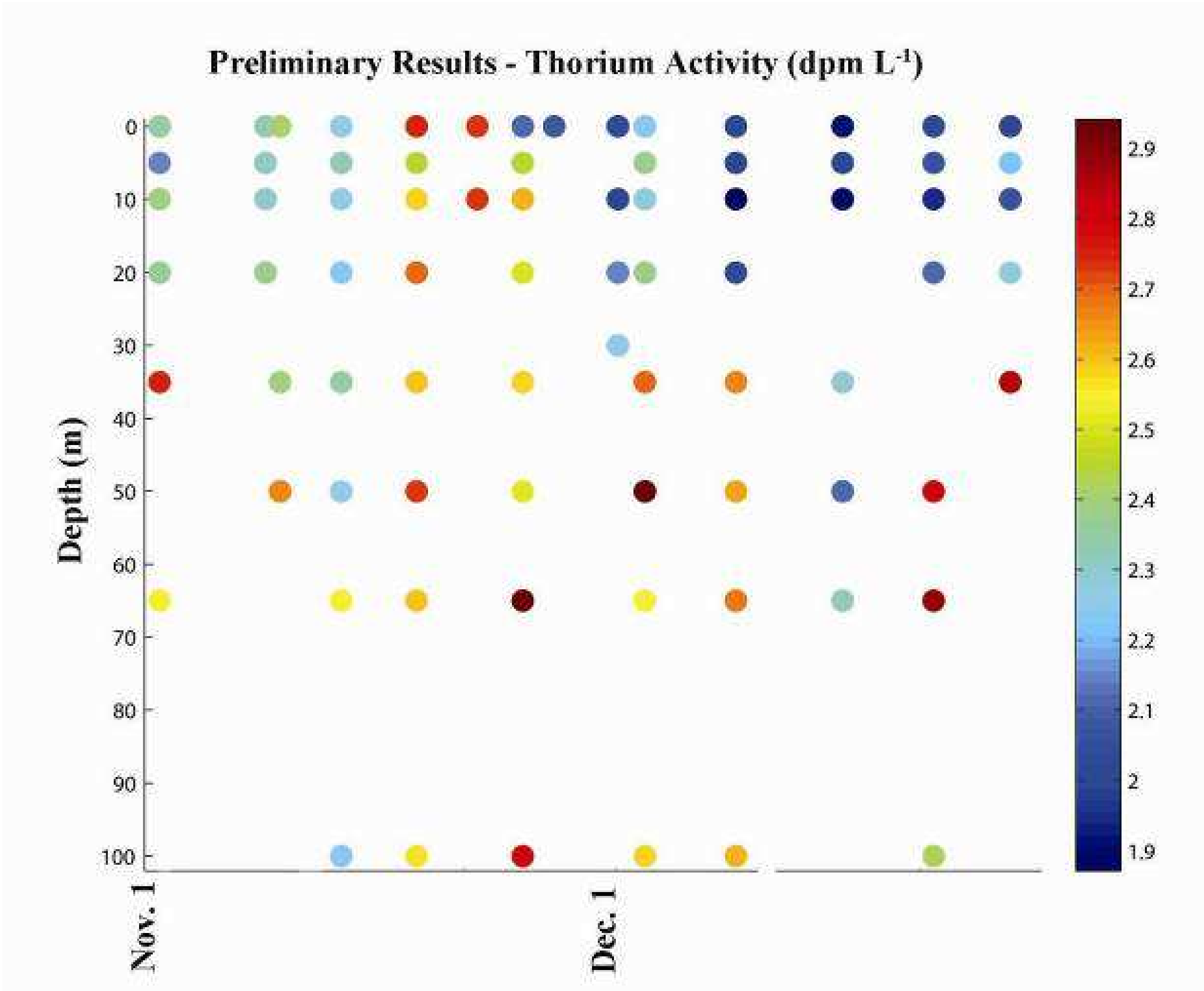
We would like to thank all of the ASC employees for their continued support of our research.

B-252-P THE SEASONAL CYCLE OF EXPORT PRODUCTION IN AN ANTARCTIC COASTAL MARINE ECOSYSTEM

Dr. Hugh Ducklow, Principal Investigator, The Ecosystems Center, Marine Biological Laboratories, Woods Hole, MA

Personnel on station: Mike Stukel

We have continued our measurements of new and export production with weekly measurements of ^{234}Th concentration (8 depths – 0, 5, 10, 20, 35, 50, 65, 100m) and twice weekly measurements of $^{15}NO_3$ uptake (0, 5, 10, 20, 65m). Preliminary results (shown in figure) are indicative of strong drawdown of ^{234}Th, in late November, which coincided with the crash of a large diatom bloom (though we must caution that until we conduct background counts and yield analyses, the error bars on our measurements should be considered ±0.25 d pm L^{-1}).



Microscopic analysis of the contents of a sediment trap deployed at 50m at Station B (during November) and Station E (during December) suggest that during and following the bloom crash, vertical flux was dominated by krill fecal pellets. These same sediment trap samples, along with Monsoon pumped >50-µm particles and weekly profiles (7 depths) of total particulate ^{234}Th, will allow us to assess the N: C:^{234}Th ratio of sinking particles and hence convert our thorium measurements to total vertical carbon and nitrogen flux.

O-176-P SUBMARINE GROUNDWATER AND FRESHWATER INPUTS ALONG THE WESTERN ANTARCTIC PENINSULA

Dr. Reide Corbett, Principal Investigator, and Dr. Kimberly Null, Co-PI, Institute for Coastal Science and Policy, East Carolina University

Personnel on station: Reide Corbett, Jared Crenshaw, David Hawkins, and Leigha Peterson

The overarching goal of this project is to quantify the rate and chemical signature of the freshwater discharging into the coastal area near Anvers Island, on the Western Antarctic Peninsula. As part of this project and while we were aboard the *ARSV Laurence M. Gould* (LMG) in mid-December, we hope to evaluate the rate that water is mixing from the shoreline across the continental shelf. This lateral mixing from the coastal zone to waters offshore will transport land-derived chemical components such as iron (Fe) and other nutrients. The Southern Ocean is considered a high nutrient low chlorophyll (HNLC) environment and iron is thought to be bio-limiting for phytoplankton growth. To quantify the mixing of iron across the shelf, and ultimately the actual source of the water, such as ice sheet melting and groundwater discharge, we are using different naturally occurring radioactive and stable isotopes as tracers of water movement. The variation in activity and isotopic signature of these tracers in samples collected across the shelf will provide information on the age and the source (fresh vs. ocean) of the water.

During the 5-day cruise on the LMG, we established multiple transects that run perpendicular from the shoreline across the continental shelf near Anvers Island. We occupied 35 stations, and at each station we collected large volumes of water for analysis of water tracers. The water was filtered and analyzed in the laboratories on the ship or stored for analysis back at our home institutions. We analyzed samples on the ship for the element radium (Ra), specifically the short-lived Ra-224, and the radioactive gas radon (Rn), Rn-222. The source of these tracers will either be from the sediments on the ocean floor or from groundwater onshore (Figure 1). We collected sediments from each station to determine if these are a significant source of the tracers. Other samples to be analyzed back home, include those for nutrients (nitrate, orthophosphate, silicate, and ammonium), helium (He), and isotopes of oxygen (O-18) and hydrogen (H-2) that will help decipher the source of the water. Preliminary results of surface activities of Ra-224 and Rn-222 from the offshore cruise demonstrate the complexity of surface currents that may be playing a role in surface activities (Figure 2). Further data analysis of depth profiles of Ra and Rn in addition to other parameters will provide more insight to the dynamic structure of the continental shelf waters.

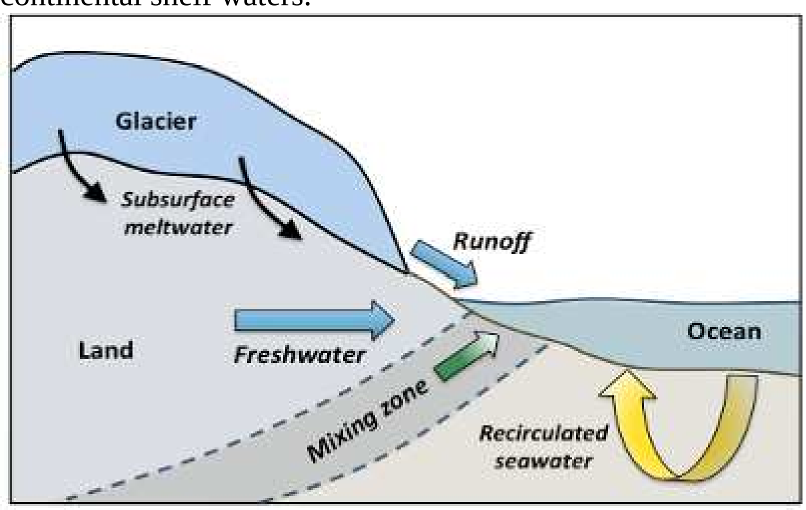


Figure 1. General schematic of submarine groundwater discharge comprised of subsurface flow of freshwater and infiltrated seawater. Size of arrow does not represent proportion of flux.

At Palmer Station, our work will focus on many of these same tracers, but our major scientific goal is slightly different. Again, our offshore work is primarily focused on evaluating mixing across the shelf. Our research at Palmer Station will focus on determining the amount of freshwater entering the coastal ocean and its source, groundwater or direct run off from ice sheet melting (Figure 1). In the nearshore waters at Palmer Station we have already occupied 20 stations and hope to include some land based sampling of groundwater near the shoreline at several locations (Figure 3). At the land stations, resistivity will also be measured as another tool to estimate groundwater discharge to the coastal ocean.

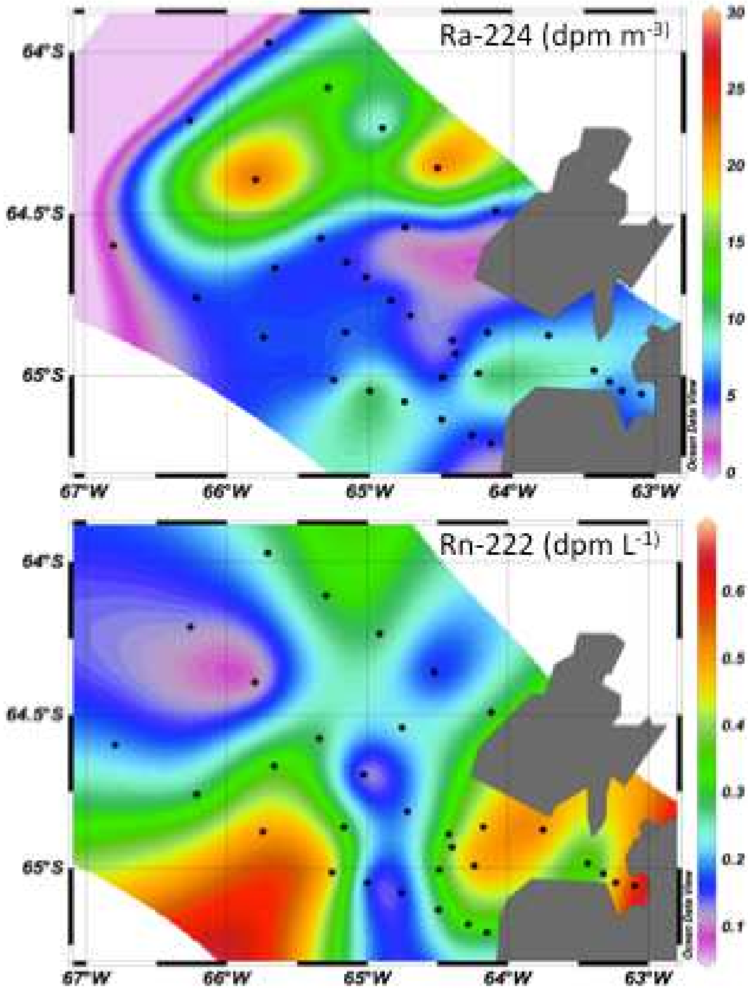


Figure 2. Ra-224 (dpm m^{-3}) and Rn-222 (dpm L^{-1}) surface water activities measured aboard the *ARSV Laurence M. Gould* 12/14/12 – 12/19/12.

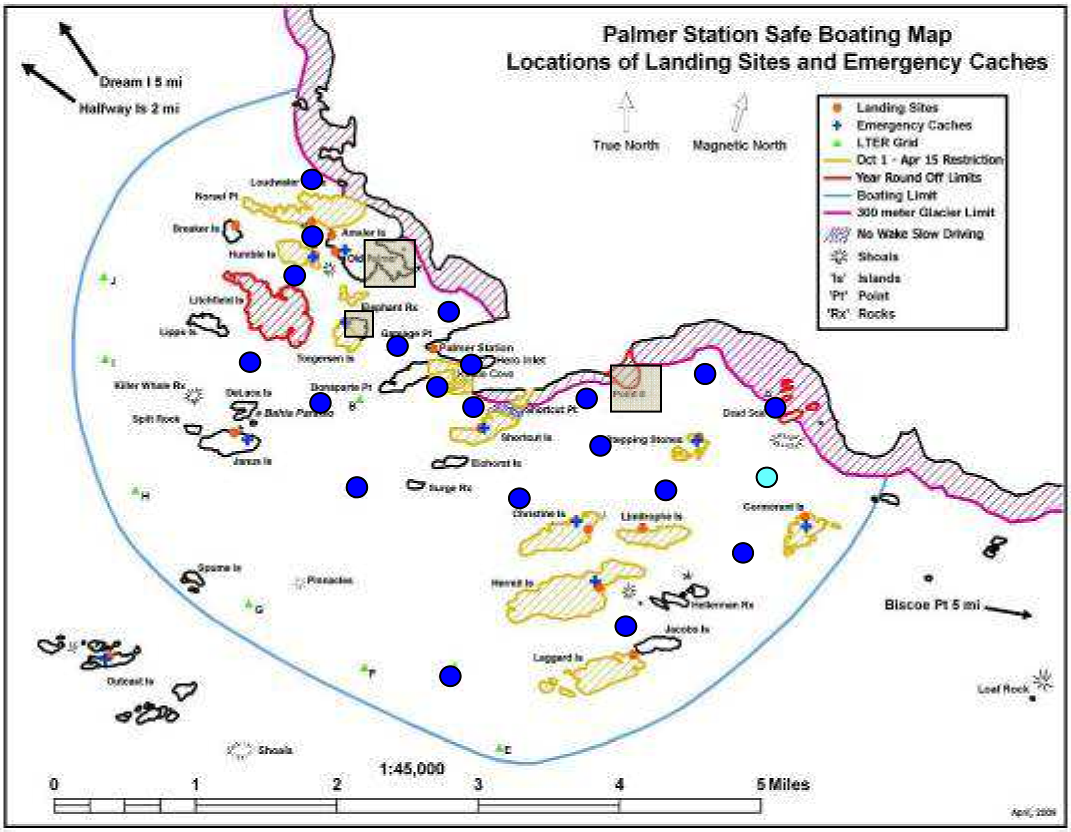


Figure 3. Sites sampled (blue closed circle) and possible land-based sites for groundwater collection and resistivity (shaded boxes) overlain on the Safe Boating Area Map for Palmer Station.

PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT
December 2012
By Glenn Grant

G-090-P: GLOBAL SEISMOGRAPH NETWORK (GSN) SITE AT PALMER STATION.
Kent Anderson, Principal Investigator, Incorporated Research Institutions for Seismology (IRIS)

Station PMSA is one of more than 150+ sites in the GSN, monitoring seismic waves produced by events worldwide. Real-time telemetry data is sent to the U.S. Geological Survey (USGS). The Research Associate operates and maintains on-site equipment for the project.

The system operated normally throughout the month.

A-109-P: ANTARCTIC EXTREMELY LOW FREQUENCY/VERY LOW FREQUENCY (ELF/VLF) OBSERVATIONS OF LIGHTNING AND LIGHTNING-INDUCED ELECTRON PRECIPITATION (LEP).
Robert Moore, Principal Investigator, University of Florida

ELF/VLF radio wave observations at Palmer Station are used to provide a deeper understanding of lightning and its effects on the Earth's inner radiation belt. The Research Associate operates and maintains on-site equipment for the project.

All data collection operations were normal.

A-132-P: FABRY-PEROT INTERFEROMETER (FPI)
Qian Wu, Principal Investigator, National Center for Atmospheric Research

The Fabry-Perot Interferometer observes mesospheric and thermospheric neutral winds and temperatures at Palmer Station by measuring the wind-induced Doppler shift in the air's nightglow emissions. The Research Associate operates and maintains on-site equipment for the project.

The system is shut down for the season.

O-202-P: ANTARCTIC METEOROLOGICAL RESEARCH CENTER (AMRC) SATELLITE DATA INGESTOR.
Mathew Lazzara, Principal Investigator, University of Wisconsin

The AMRC computer processes satellite telemetry received by the Palmer Station TeraScan system, extracting Automated Weather Station information and low-resolution infrared imagery and sending the results to AMRC headquarters in Madison, WI. The Research Associate operates and maintains on-site equipment for the project.

The data ingestor operated normally for the month.

O-204-P: A STUDY OF ATMOSPHERIC OXYGEN VARIABILITY IN RELATION TO ANNUAL TO DECADAL VARIATIONS IN TERRESTRIAL AND MARINE ECOSYSTEMS.
Ralph Keeling, Principal Investigator, Scripps Institution of Oceanography

The goal of this project is to resolve seasonal and interannual variations in atmospheric O_2 (detected through changes in O_2/N_2 ratio), which can help to determine rates of marine biological productivity and ocean mixing as well as terrestrial and oceanic distribution of the global anthropogenic CO_2 sink. The program involves air sampling at a network of sites in both the Northern and Southern Hemispheres. The Research Associate collects samples fortnightly from both TerraLab and the VLF Building.

Some samples during December were postponed due to unfavorable wind conditions.

O-264-P: COLLECTION OF ATMOSPHERIC AIR FOR THE NOAA/GMD WORLDWIDE FLASK SAMPLING NETWORK
James Butler, Principal Investigator, National Oceanic and Atmospheric Administration / Global Monitoring Division; Boulder, CO

The NOAA ESRL Carbon Cycle Greenhouse Gases (CCGG) group makes ongoing discrete measurements to document the spatial and temporal distributions of carbon-cycle gases and provide essential constraints to our understanding of the global carbon cycle. The Halocarbons and other Atmospheric Trace Species (HATS) group quantifies the distributions and magnitudes of the sources and sinks for atmospheric nitrous oxide (N2O) and halogen containing compounds. The Research Associate collects weekly air samples for the CCGG group and fortnightly samples for the HATS group.

Carbon Cycle and Halocarbon sampling occurred normally during the month.

O-264-P: ULTRAVIOLET (UV) SPECTRAL IRRADIANCE MONITORING NETWORK
James Butler, Principal Investigator, National Oceanic and Atmospheric Administration / Global Monitoring Division; Boulder, CO

A Biospherical Instruments (BSI) SUV-100 UV spectroradiometer produces full sky irradiance spectra ranging from the atmospheric UV cutoff near 290nm up to 605nm, four times per hour. A BSI GUV-511 filter radiometer, an Eppley PSP Pyranometer, and an Eppley TUVR radiometer also continuously measure hemispheric solar flux within various spectral ranges. The Research Associate operates and maintains on-site equipment for the project.

The UV monitor collected data normally throughout the month. The seasonal triple absolute scan was completed.

O-283-P: ANTARCTIC AUTOMATIC WEATHER STATIONS (AWS).
Mathew Lazzara, Principal Investigator, University of Wisconsin

AWS transmissions from Bonaparte Point are monitored using the TeraScan system and the Data Ingestor system. Data collected from this station is freely available from the University of Wisconsin's AMRC website. The Research Associate monitors data transmissions for the project and performs quarterly maintenance on the station at Bonaparte Point.

The Bonaparte Point automated weather station is currently at the home institution for refurbishment.

T-295-P: GPS CONTINUOUSLY OPERATING REFERENCE STATION.
Joe Pettit, Principal Investigator, UNAVCO

Continuous 15-second epoch interval GPS data files are collected at station PALM, compressed, and transmitted to the NASA-JPL in Pasadena, CA. The Research Associate operates and maintains on-site equipment for the project.

The GPS receivers operated normally for the month.

A-336-P: ELF/VLF OBSERVATION OF LIGHTNING DISCHARGE, WHISTLER-MODE WAVES AND ELECTRON PRECIPITATION AT PALMER STATION.
John Gill, Principal Investigator, Stanford University

Stanford University has been operating a Very Low Frequency (VLF) receiver antenna at Palmer Station since the 1970's. By receiving naturally and manmade signals between 1 and 40 kHz, the Stanford VLF group is able to study a wide variety of electromagnetic phenomenon in the ionosphere and magnetosphere. The Research Associate operates and maintains on-site equipment for the project.

The VLF cable and antenna system were inspected; all antenna hardware remains stable. The system collected data throughout the month, however automated data transfers to hard drives and via the Internet failed on several occasions for a variety of reasons. As of the end of the month the system is collecting data normally.

T-312-P: TERASCAN SATELLITE IMAGING SYSTEM
The TeraScan system collects, processes, and archives DMSP and NOAA satellite telemetry, capturing approximately 25-30 passes per day. The Research Associate operates and maintains on-site equipment for the project.

The TeraScan system operated normally throughout the month.

A-357-P: EXTENDING THE SOUTH AMERICAN MERIDIONAL B-FIELD ARRAY (SAMBA) TO AURORAL LATITUDES IN ANTARCTICA
Eftyhia Zesta, Principal Investigator, University of California Los Angeles

The three-axis fluxgate magnetometer is one in a chain of longitudinal, ground-based magnetometers extending down though South America and into Antarctica. The primary scientific goals are the study of ULF (Ultra Low Frequency) waves and the remote sensing of mass density in the inner magnetosphere during geomagnetically active periods. The Research Associate maintains the on-site system.

The magnetometer operated normally throughout the month.

B-466-P: FLUORESCENCE INDUCTION AND RELAXATION (FIRe) FAST REPETITION RATE FLUOROMETRY (FRRF)
Deneb Karentz, Joe Grzymski, Co-Principal Investigators, University of San Francisco

The focus of this project is to identify and evaluate changes that occur in genomic expression and physiology of phytoplankton during the transition from winter to spring, i.e., cellular responses to increasing light and temperature. A Fast Repetition Rate Fluorometer (FRRF) with a FIRe (Fluorescence Induction and Relaxation) sensor is installed in the Palmer Aquarium. The Research Associate downloads data and cleans the instrument on a weekly basis.

The FRRF was cleaned on a weekly basis and the data sent to the PIs. An analysis of the data suggests that the cleaning schedule may need to be augmented to maintain system accuracy during the summer season.

T-998-P: INTERNATIONAL MONITORING STATION (IMS) FOR THE COMPREHENSIVE NUCLEAR TEST BAN TREATY ORG. (CTBTO)
Managed by General Dynamics

The IMS Radionuclide Aerosol Sampler and Analyzer (RASA) is part of the CTBTO verification regime. The automated RASA continually filters ambient air and tests for particulates with radioisotope signatures indicative of a nuclear weapons test. The Research Associate operates and maintains the instrument.

The system operated normally throughout the month.

TIDE GAGE
Tide height and seawater temperature are monitored on a continual basis by a gauge mounted at the Palmer Station pier. The Research Associate operates and maintains on-site equipment for the project.

In general, the system operated normally. The system is not robust to local network outages, and was stopped briefly when the network was unavailable.

METEOROLOGY
The Research Associate acts as chief weather observer, and compiles and distributes meteorological data. Weather data collected using the automated electronic system is archived locally and forwarded twice each month to the University of Wisconsin for archiving and further distribution. Synoptic reports are automatically generated every three hours by the Palmer Meteorological Observing System (PalMOS) and emailed to the NOAA for entry into the Global Telecommunications System (GTS).

The weather station was inspected and cleaned. All operations were normal during December.