PALMER STATION MONTHLY SCIENCE REPORT
MAY 2014

Blackfin Icefish, *C. aceratus*; a white-blooded Antarctic notothenioid species studied by Detrich (B-037)
(*Image Credits: Linnah Neidel)*

NEWS FROM THE LAB

Linnah Neidel, Winter Laboratory Supervisor

The first half of May was a productive time at Palmer Station for the science projects of the LMG14-04 cruise. The *ARSV Laurence M. Gould* (LMG) conducted two multi-day fishing trips in support of Detrich (B-037), fortifying their stocks of fish in the aquaria. While in sight of Palmer Station, the LMG was used by Klein (B-518) as a platform to collect benthic sediments.

The laboratories and aquaria were the sight of much activity. High-speed imaging and tomography equipment were installed and utilized by the Yen group (B-048), while the Detrich group (B-037) prepared an incubator system for embryo work and collected tissue samples from various fish species. T. Desvignes (B-037), J. Yen, and D. Adhikari (both B-048) shared their work with the community by giving "Show and Tells" of fish dissection, high speed imaging, and tomography, respectively.

With mild conditions in much of May, several outdoor projects were advanced including the boat ramp, and the Zodiac parking decks. The VLF tower was successfully raised for Moore (A-109), and Klein (B-518) and the divers were able to sample near-station sediments from the pier environs and via Zodiac.

May 15th saw the departure of the LMG, back to Punta Arenas and then off to dry-dock. Station personnel were reduced to 19 individuals: the winter-over ASC personnel and two grantees from B-037. The grantees continued collecting tissue samples and monitoring the fish populations for ripened eggs from the females. By the end of the month, the first embryos, of C. aceratus, had been introduced to the incubator. The labs have eased into a winter routine that will continue until the arrival of the next group of Palmer scientists at the end of June.

MAY 2014 WEATHER
Graham Tilbury, Research Associate

Overall, the weather during May month was very mild. Only during the second half of the month did minimum temperatures begin dropping below -3.0ºC, before reaching a low of -7.4ºC on the 24th. During the first half of the month, maximum temperatures remained above zero, reaching a max of 8.5ºC on the afternoon of the 9th.The average temperature for the month was 0.9ºC, making it a much warmer May than last year.

Except for a few periods of low winds, May was a rather windy month. For ten days the winds gusted above 40 knots, reaching a max of 60 knots on the 29th. Shortly after the middle of the month, a high pressure system settled over the station for several days, reaching its highest level of 1014.9mb on the 19th. During the latter half, the winds blew daily from the N.

The sea surface temperature dropped steadily from a start of -0.5ºC down to a low of -1.6ºC at the end of the month. A few very large icebergs passed well offshore of the station. The Arthur Harbor glacier continued calving steadily throughout the month. Total snowfall was only 14 cm, less than half last May's total.

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

Personnel on station: Neal Dupree, Daniel Kotovsky

Final checks on the new VLF tower and antenna system (now in the Backyard) were made by grantees Neal Dupree and Daniel Kotovsky. This new system has been working excellently, without problems, and will continue to be monitored by: the grantees, remotely; and the RA, on-site. Additionally, inventory lists and organization were completed by the visiting grantees, who departed Palmer mid-May.

B-037-P: PROTEIN FOLDING AND EMBRYOGENESIS IN ANTARCTIC FISHES: A COMPARATIVE APPROACH TO ENVIRONMENTAL STRESS

H. William Detrich, Principal Investigator, Marine Science Center, Northeastern University

Personnel on Station: H. William Detrich, Thomas Desvignes, Yinan Hu, Urjeet Khanwalkar Nathalie Le François, and Eileen Sheehan

Antarctic notothenioid fishes, which have evolved cold-adapted, stenothermal physiologies, are now threatened by rapid warming of the Southern Ocean, the temperature of which is likely to increase by 2-5°C over the next two centuries. The long-term goals of my research program are to assess the molecular and organismal consequences of this warming by two experimental strategies: 1) characterization of the functional properties of the protein-folding machine, the chaperonin CCT, from notothenioid fishes at physiological and supra-physiological temperatures; and 2) analysis of the effects of elevated temperature regimes on gene expression by developing embryos of red- and white-blooded Antarctic notothenioids. Therefore, our field objectives are: 1) to obtain CCT from testis tissue of the Humphead notothen, *Gobionotothen gibberifrons*, to support experimentation at my home laboratory; and 2) to carry out long-term incubations of embryos from the Bullhead notothen, *Notothenia coriiceps*, and from the Blackfin icefish, *Chaenocephalus aceratus*, at control (–1°C) and experimental (+4°C) temperatures. Embryos sampled at intervals will be analyzed for thermal perturbation of gene expression by high-throughput RNA sequencing (RNAseq).

May was a busy month for B-037 as we focused on concluding our short-term field objectives, preparing for our winter research program, and planning the retrograde of most B-037 personnel and some samples to the US. We finished freezing testis tissue of *G. gibberifrons* for future CCT experiments. On 24 May, Le François and Sheehan introduced the first *in-vitro*-fertilized *C. aceratus* embryos into the Aquamerik incubator, but their viability is questionable. Meanwhile, *N. coriiceps* are almost ripe, and embryos should be available in early June for our thermal acclimation experiments. As we reduced our fish stocks, we have taken tanks off-line and cleaned them for use by research projects that will arrive on *ARSV Laurence M. Gould* cruise 14-06. The Palmer Station Aquarium seawater system continued to operate within expected parameters, with indoor tanks averaging +0.5-0.6°C and outdoor tanks +0.2-0.5°C.

We collected fish specimens for our field program during two fishing trips on the *LMG*. On the first (03-06 May), the *LMG* sailed south for a combined expedition: 1) deployment of a cGPS system at Prospect Point in support of C-313 (Domack, PI); and 2) fishing in the Banana Trench (B-037). On 04 May, the ASC "away team" installed the cGPS system in 5 hours and successfully tested it. The *LMG* then sailed for the Banana Trench, where fishing began in the early hours of 05 May. Six trawls were performed at depths of 880-920 m, and we collected small numbers of dragonfish and plunderfish. The second fishing trip returned to the Low Island grounds (ASPA 152, Western Bransfield Strait) on 10-12 May, where we collected specimens of our three major target species, *C. aceratus*, *G. gibberifrons*, and *N. coriiceps*, at depths of 160-180 m. Following each fishing trip, we off-loaded the live specimens to the Palmer Aquarium with the able assistance of the *LMG* and Palmer logistics personnel.

On 15 May, Detrich, Desvignes, Hu, and Khanwalkar departed Palmer Station for Punta Arenas, Chile. Le François and Sheehan are wintering at Palmer to maintain and sample our embryo cultures as development proceeds. We thank the crew of the *ARSV Laurence M. Gould* and the

ASC personnel of Palmer Station for their mission-critical help to our on-going field research program.

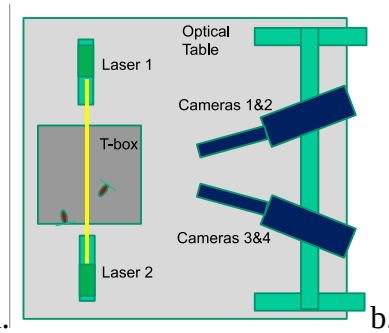
B-048-P: COLLABORATIVE RESEARCH: PTEROPOD SWIMMING BEHAVIOR AS A BIO ASSAY FOR OCEAN ACIDIFICATION

Jeanette Yen, Principal Investigator, Georgia Tech

Personnel on Station: Jeanette Yen, Deepak Adhikari, Rajat Mittal, Rebecca Wolf.

Our goal is to develop a behavioral assay to provide an early warning of the effects of ocean acidification. Our focus is on the plankton, a key link in the aquatic food web. The behavior of interest is the locomotion by the planktonic mollusk *Limacina helicina*. Using an interdisciplinary approach, we document the biomechanics of propulsion by plankton as input to computational fluid dynamics models that will be used to predict how the behavior changes with variation in shell weight. These predictions will be validated against the fluid mechanics of biologically generated flow created as they swim.

Our team successfully set up our flow visualization system (Fig. 1) where digital image data recorded by 4 high speed high resolution cameras observing fluid-animal interactions created by 4-60 mm organisms, specifically pteropod, copepods, and krill, illuminated by two infrared lasers.

a. 

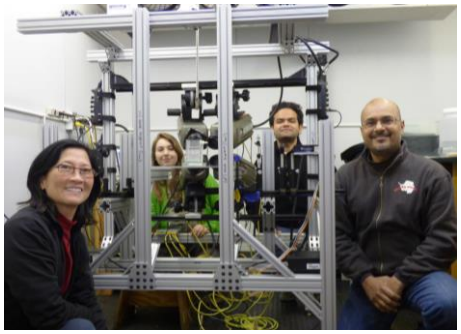
b. 

Figure 1. a. The tomography system consists of: 4 Phantom v210 cameras, capable of 2190 fps at 1280 x 800 pixels. Each is equipped with a 105 mm lens on a Scheimpflug mount. Two 7 W CW lasers illuminate the interrogation volume ~1-2 cm^3 with counter-propagating Near IR (808 nm) that does not modify plankton behavior. LaVision analysis software provides MART volume reconstruction and the 3D cross-correlation analysis via a 24-processor server. b. Tomography system in the 0 degree C cold room at Palmer Station

This pass of the krill [Figure 2] will be processed and analyzed to show the measured volumetric flow velocity field around the organism. The vector field will be used to identify flow structures around the organisms as it propels, thus allowing us to understand how the metachronal motion of the pleopods allows the krill to hover and move forward.

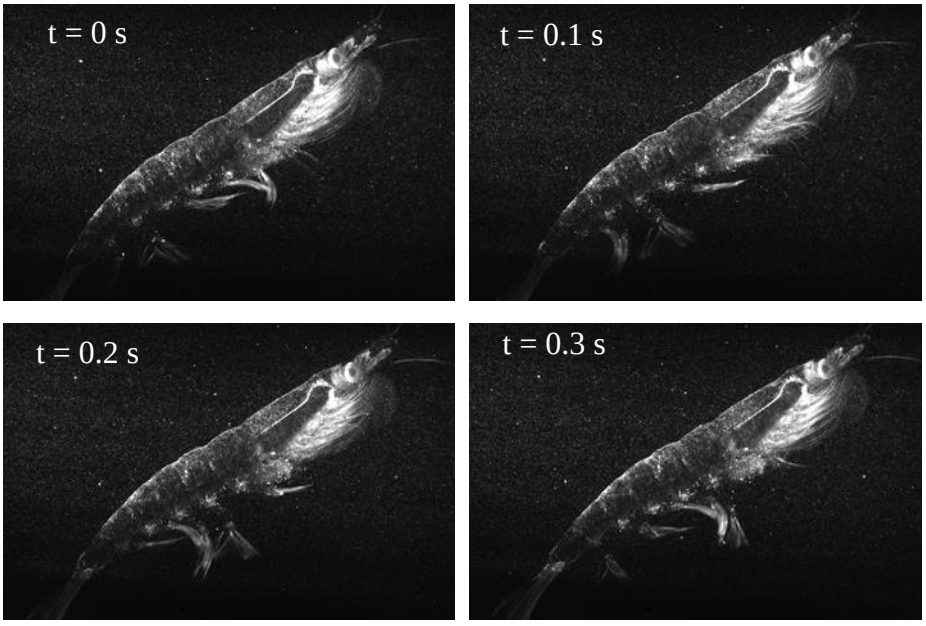


Figure 2: Time sequence of the metachronal pleopod movement of a krill from one of the four cameras.

Similar images for copepods and *S. australis* also were obtained at Palmer Station. Vector fields generated from these results provide a platform for comparison with computational fluid dynamics model (see Fig. 4 below).

This system uses AOS high speed high resolution cameras (Fig. 3a) to document the 3D movements of propulsive appendages. This pair of images (Fig. 3bc) shows how the copepod paddle expands to propel itself at accelerations of more than 3g.

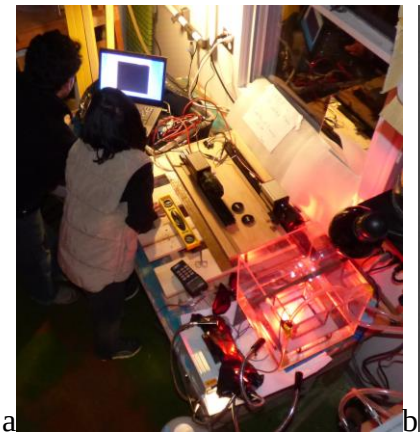
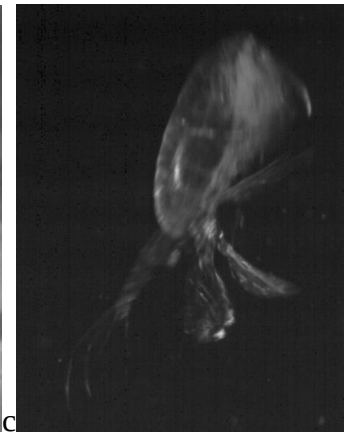
a  b  c 

Fig. 3. a. High speed high resolution imaging system comprised of 2 AOS computer videocameras are oriented to record orthogonal images to track the x,y,z,t coordinates of propulsor limb movements. High magnification orthogonal images [b,c] of the propulsive appendages of an adult female *Euchaeta antarctica* (8 mm prosome length) taken at 500 fps.

Among the organisms collected from Palmer Deep and Anvord Bay, we identified an unusual shell-less *gymnosome* pteropod, *Spongiobranchaea australis* http://speciesidentification.org/species.php?species_group=Pelagic_molluscs&id=182,

Videographic analysis of this organism conducted at Palmer Station indicated that the flapping locomotion of this organism was unlike anything reported before: it exhibited flapping using overlapping propulsive wings (see Fig. 4abc).

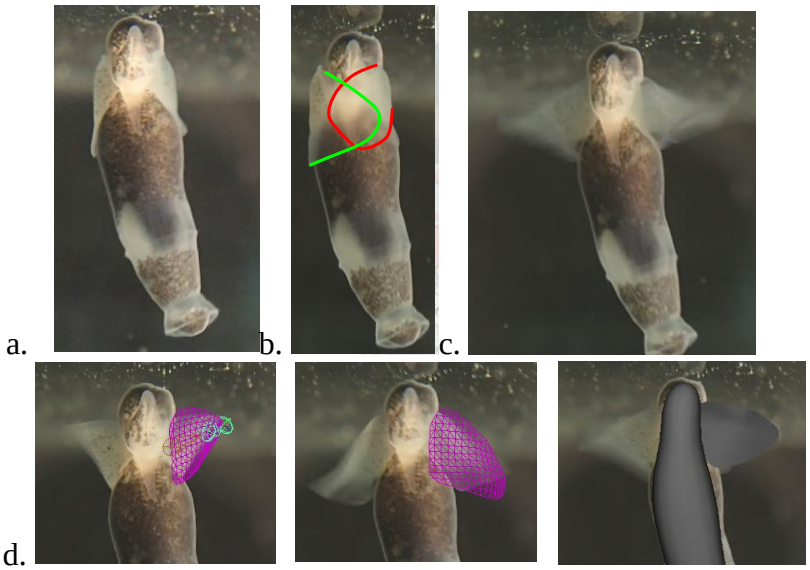


Fig. 4: Snapshots showing the flapping kinematics of *S australis*. Shot (a) shows abducted wings (b) with overlap and shot (c) shows wings outspread. (d) Development of MAYA model of *S. australis*.

An example of our video records can be found at:
https://www.youtube.com/watch?v=J5LomubgdlM&feature=youtu.be
Literature reviews showed that little or no behavioral studies have been performed in this species. Analyses of the wing movements of *Spongiobranchaea australis* were conducted using using Maya in preparation for CFD modeling studies. (Fig. 4d)

B-518-P: TOWARD ENHANCED MONITORING OF HUMAN IMPACTS IN COLD REGIONS

Dr. Andrew Klein, Principal Investigator, Texas A&M University; Dr. Paul Montagna, Co-PI, Texas A&M-Corpus Christi, Dr. Terry Wade, Dr. Jose Sericano and Mr. Stephen Sweet, Co-PIs Texas A&M University

Personnel on station: Andrew Klein and Stephen Sweet

The focus of the project is to establish a long-term environmental monitoring program which examines the impact of science and operations on the local Palmer environment both on land and offshore. This is an extension of the environmental monitoring program we have operated at McMurdo Station beginning in 1999.

With the help of station and LMG personnel, B-518 had a very successful initial deployment to Palmer Station. Benthic sediments samples were collected using a Smith-McIntyre grab sampler deployed from the Laurence M. Gould and by diver sampling (Rob Robbins, Steve Rupp and Jack Baldelli) using coring tubes. The cores are being shipped back to Texas A&M University in College Station to be analyzed for various petroleum hydrocarbons and other common environmental contaminants. A subset of the samples will be analyzed at Texas A&M- Corpus

Christi to investigate the benthic infauna communities. These analyses will guide the final design of a monitoring program which will be implemented during the 2014-2015 field season.

Operating off of the Laurence M. Gould, sediment samples were collected at twenty-three locations (filled green circles in Figure 1). These sites represented sites that were sampled following the Bahía Paraíso spill in 1989 for petroleum hydrocarbons (the PD sites in Figure 1) as well as sites from previous studies of local benthic communities (the RH and SB sites in Figure 1). Some sites from previous studies (the open circles in Figure 1) could not be safely reached. This successful sampling will enable us to examine how petroleum hydrocarbon levels have changed over the intervening years since the Bahía Paraíso spill and will provide a useful comparison of the benthic community structure we measure to two historical studies conducted based on samples collected at the same locations in the past.

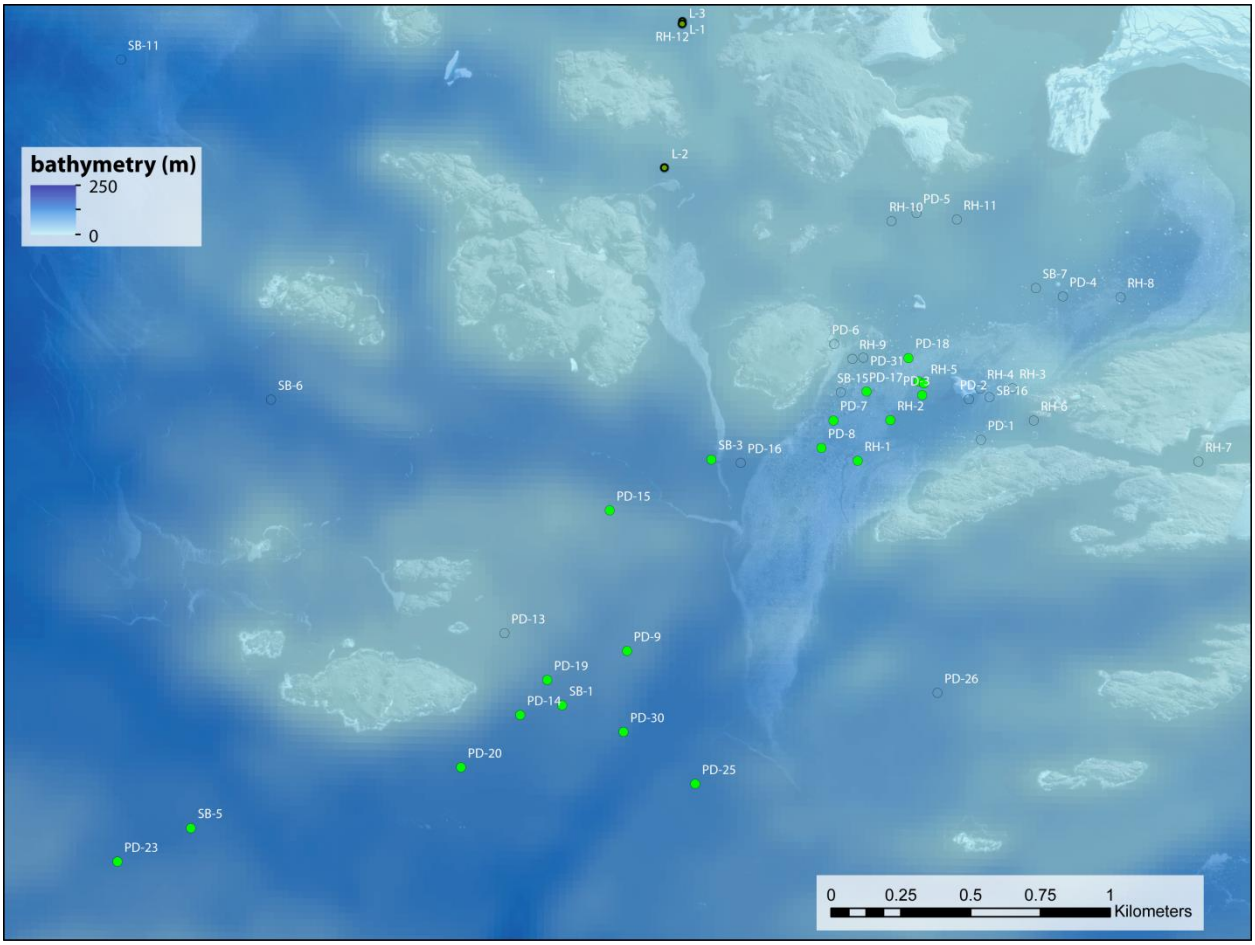


Figure 1. Location of samples collected from the L.M. Gould (filled green circles) as well as sites from earlier studies that could not be safely reached (open circles). The blue graded colors indicate water depth and the background image is a WorldView-2 satellite image from March 24, 2013 courtesy of the Polar Geospatial Center.

An additional nineteen sites were sampled using the station divers off both Palmer and Old Palmer stations (Figures 2 and 3, respectively). These sites were selected to be representative of areas with possible ongoing environmental impacts (off the sewage outfall and off of the Pier). Areas previously sampled for petroleum hydrocarbons near both Palmer and Old Palmer station were reoccupied. Several possible areas near Palmer that could possibly be used as non-impacted control sites were also sampled. Sampling depths typically were 40, 60 or 80 feet except in Hero Inlet where the sampled depths ranged from 20 to 54 feet. The diver sampling was viewed as highly successful as it was demonstrated that sediments suitable for sampling by divers exist in proximity to the station. This will enable development of a marine sampling program quite similar to that successfully being utilized at McMurdo.

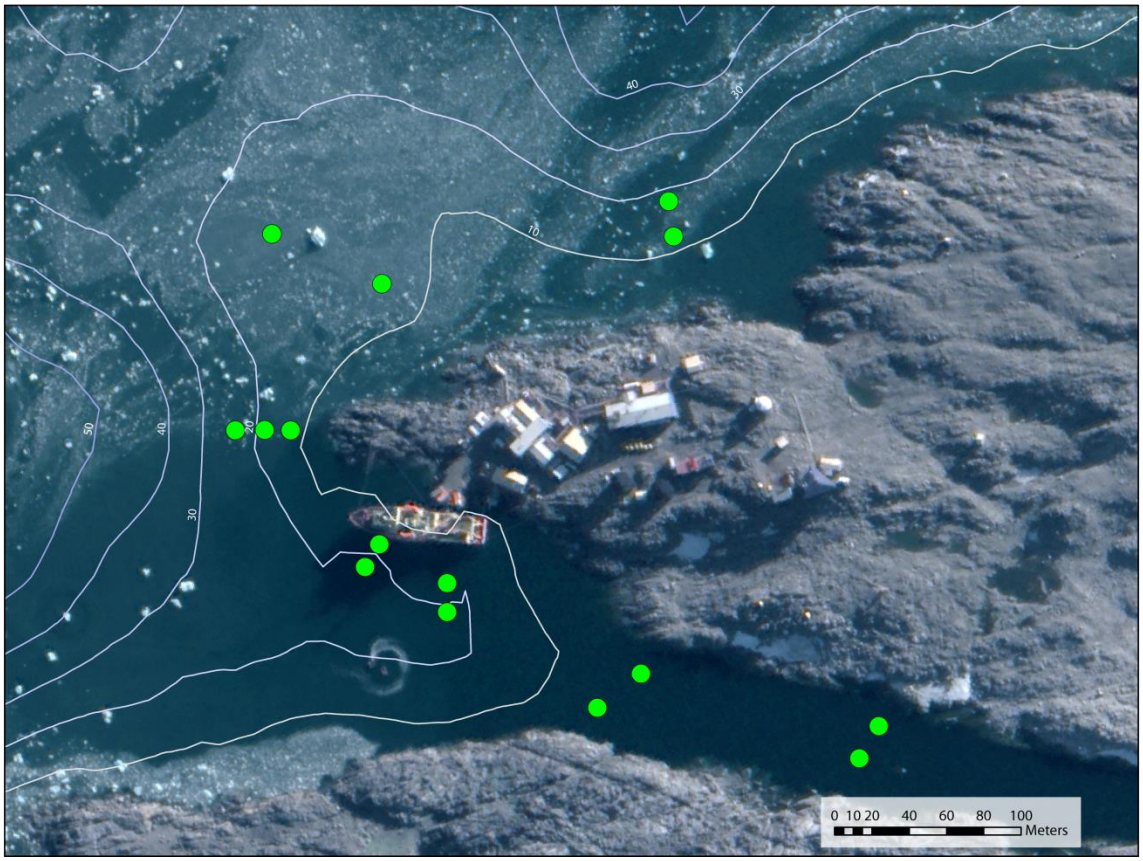


Figure 2. Diver collected sampling sites near Palmer Station. The background image is a WorldView-2 satellite image from March 24, 2013 courtesy of the Polar Geospatial Center.

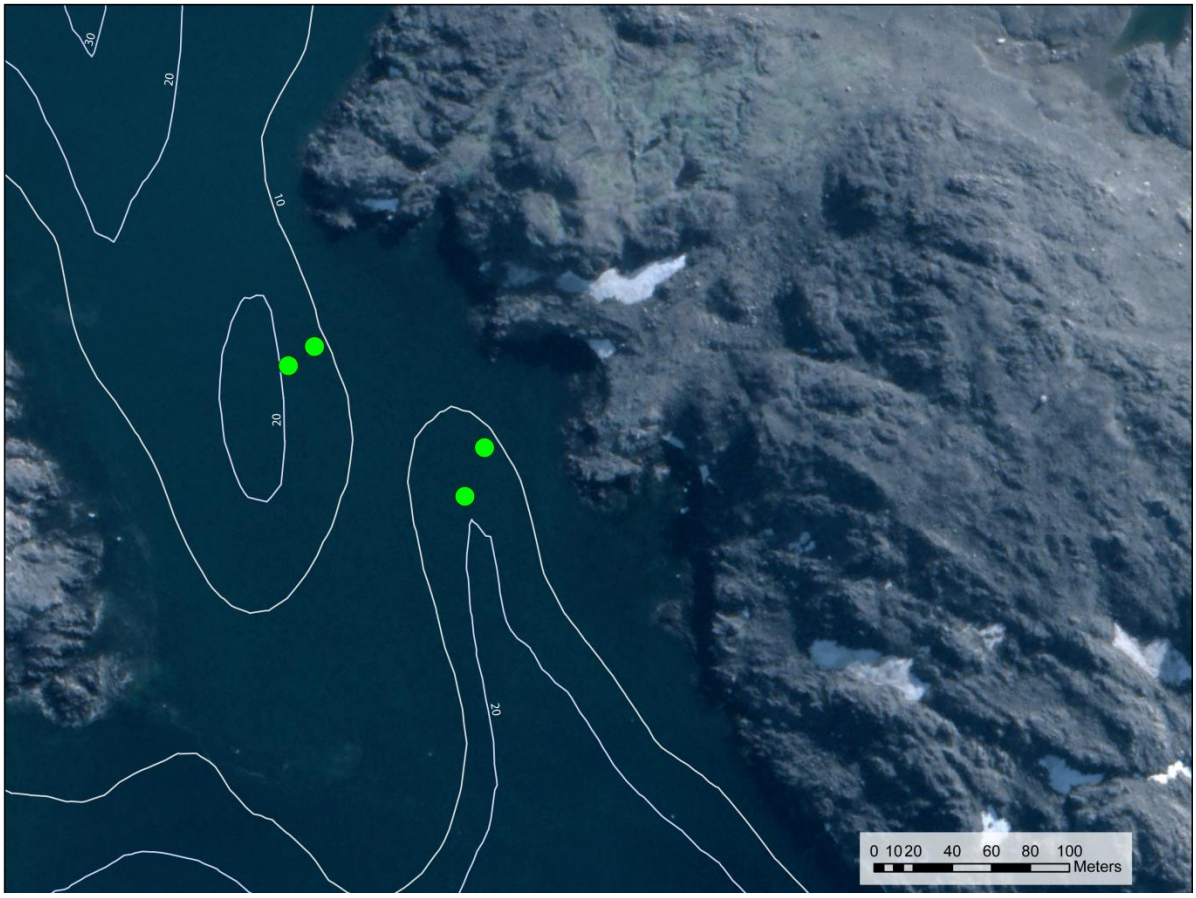


Figure 3. Diver collected sampling sites near Old Palmer Station. The background image is a WorldView-2 satellite image from March 24, 2013 courtesy of the Polar Geospatial Center.

In addition to the marine-focused sampling, reconnaissance investigations and discussions with station personnel were also carried out in order to construct the sampling scheme that will be used to collect terrestrial soils in and around both Palmer and Old Palmer Stations in upcoming seasons.

We appreciate all the support we received both from station and LMG personnel!

PALMER STATION RESEARCH ASSOCIATE MONTHLY REPORT
MAY 2014
Graham Tilbury

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.

The new VLF tower was inspected after two 50 knot wind episodes and looked totally secure. The system operated normally throughout the month.

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 through 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.

Air samples were collected as scheduled.

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 air samples were collected as scheduled.

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 system operated normally throughout the month.
The bi-weekly absolute calibration scans were completed as scheduled.

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 University of Wisconsin's 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.

During a 75knot storm in early May, the wind speed and direction unit was damaged.
It was removed and repaired in the lab, before being re installed on the tower.
Since the repair, daily data checks confirm the system is again operating normally.

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 primary GPS station collected data normally throughout the month.
The replacement NASA computer continues operating correctly.

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 weather and ice imagery is used for both research and station operations.

The scheduled satellite passes were captured, recorded, and distributed 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.

All daily instrument checks, weekly cleaning and data downloads were performed as scheduled.

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 annual inspection by the CTBT Technician was successfully completed.
The system continued collecting data normally throughout the month.

OCEANOGRAPHY
Daily observations of sea ice extent and growth stage are also recorded, along with continuous tidal height, ocean temperature, and conductivity at Palmer's pier.

The new tide level, conductivity and sea water temperature monitoring system performed correctly the entire month.

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 National Weather Service for entry into the Global Telecommunications System.

The system collected data normally throughout the month.
A new display screen, incorporating images from six individual screens, is currently under development.