PALMER STATION MONTHLY SCIENCE REPORT

January 2023

The C-013-P (Cimino) field team completes penguin survey on Island 306 in the Rosenthal Islands. ACA permit #2021-002 M#2. *Image Credits: Marissa Goerke*

NEWS FROM THE LAB
Hannah James, Summer Laboratory Supervisor

The first month of 2023 was an incredibly busy and productive month for all science groups on station, despite it being one of the wetter and darker months on record. The labs were packed full with grantees- a total of nine groups had personnel on site- and when the weather allowed people to be on the water, the black board was full and station felt a bit like a ghost town. The groups that arrived in late December spent the first week setting up lab spaces, getting experiments going, and getting out in the field to dial in their sampling procedures as much as the weather allowed. The B-027-P (McClintock) diving group got all divers checked out and began filling the Aquarium with algae, amphipods, and other critters from the local waters. The C-020-P (Steinberg) team joined the LTER group and began their net tows on RHIB HADAR on a bi-weekly basis. The C-024-P (Friedlaender) group was busy on the water in search of whales and recovering their overwintering soundtrap moorings. The month wrapped up with the return of the R/V LAURENCE M. GOULD from the annual LTER cruise on the evening of January 31, swapping various personnel from different lab, and saying goodbye to the B-308-P (Moline) crew.

B-027-P: ASSEMBLAGE-WIDE EFFECTS OF OCEAN ACIDIFICATION AND OCEAN WARMING ON ECOLOGICALLY IMPORTANT MACROALGAL-ASSOCIATED CRUSTACEANS IN ANTARCTICA

James McClintock and Charles Amsler, Principal Investigators, University of Alabama at Birmingham
Personnel on station: Charles Amsler, Margaret Amsler, Addie Knight, Hannah Oswalt.

The field team arrived with LMG 23-01 on 29 December. January was a busy month devoted to preparing for our project's main ocean acidification experiment. The initial major focus of our activities was setting up for the experiment in the aquarium. This went very well and was complete within approximately ten days.

Figure 1- *B-027-P (McClintock/Amsler) on-site grantees with their main ocean acidification experiment. Image Credit- Dr. Charles Amsler.*

After the experiment setup was complete, we calibrated the delivery of CO_2-enriched air that we use to decrease the experimental pH (mimicking the anthropogenic increase in atmospheric CO_2 that is driving ocean acidification). Our ability to manipulate the pH is accomplished via microprocessors that control solenoids that individually regulate one gas line with CO_2-enriched air and a second line with unenriched, outside air to the experimental replicates. This overall process included calibrating the pH electrodes that provide real-time pH data to the microprocessors as well as calibrating the timing of the pure air flow to optimize mixing in ambient pH replicates. These calibrations are now complete.

In the laboratory, with assistance from the laboratory manager, we have setup and tested the two main instruments which will be used for daily monitoring of seawater carbonate chemistry during the experiment. These are a titrator to measure alkalinity and a spectrophotometer with water-jacket-temperature-control to precisely measure pH.

We made our gear checkout dives off the floating dock on 4 January and since that time have been making dives at various locations, primarily to collect macroalgae-associated amphipods. This is done by cutting the holdfast structure that the algae use to attach to the bottom and then as gently as possible, enveloping the detached macroalga into a large, very fine mesh bag (made from sheer curtain fabric). Back in the aquarium, the algae are cut into smaller pieces as needed and dunked and shaken multiple times to dislodge the amphipods, ultimately into plastic trays. Individuals of the large brown alga we primarily use as a source, *Desmarestia menziesii*, can support many thousands of these small, shrimp-like animals from over thirty species. To accumulate the two-plus-thousand individuals of each of four species we are planning to use in the experiment, we collect them one at a time with pipettes and transfer them to holding bottles.

Figure 2- *Top Left: Removing part of a brown alga (Desmarestia menziesii) from the fine mesh bag it was collected in to begin removing amphipods. Bottom Left: A tub with a small fraction of the amphipods removed from a single D. menziesii. The longer brown objects are pieces of the macroalga. Almost everything else in view is an amphipod. Top and Bottom Right: Sorting out individual amphipods for use in the experiment.*

Before our arrival, the laboratory manager set up two 'mesocosm' tanks on the outdoor aquarium deck and plumbed them with unfiltered water to foster formation of diatom biofilms on the sides and bottom of the mesocosms. One of our earlier dives was to collect additional epiphytic diatoms (by collecting diatom-fouled algae and invertebrates) to increase the density and diversity of the diatom assemblage. We placed plastic aquarium plants in these tanks and they now are similarly coated with a rich diatom biofilm. The diatom-coated plants will provide the primary (but not only) food source for the amphipods in the experiment. A plastic plant along with other algal food will be placed into each of four mesh enclosure cylinders in the individual buckets used in our experiment (see Figure 1). We hand carried the frames and pre-sewn window screening tubes for these enclosures with us and assembled them during our first three days on the R/V LAURENCE M. GOULD coming south.

Figure 3- *Assembling amphipod enclosure cylinders on the R/V LAURENCE M. GOULD. The tops of these are visible in the uncovered buckets in Figure 1.*

We are grateful for the generous and professional assistance from numerous ASC staff in facilitating our activities. In particular, Hannah James, who has doubled as both the laboratory manager and the instrument tech all month, has provided outstanding support. The boathouse staff, Barb Krasinski and Matt Gosselin, facilitated our boat diving activities and the IT department, Jeff Mossen and Cody Lewis, have overcome several software and hardware issues with our computer-controlled equipment.

B-086-P: Antarctica as a Model System for Responses of Terrestrial Carbon Balance to Warming

Dr. Natasja van Gestel, Principal Investigator, Department of Biological Sciences, Texas Tech University.

Personnel on station: Dr. Natasja van Gestel and Sara Bohi Goulart.

Science

Our field warming experiment is in full swing. We have been able to measure carbon fluxes in the field in all the plots about once weekly. We measure incoming (photosynthesis) and outgoing (respiration) fluxes of carbon. Will warming increase photosynthetic rates of mosses, or will it increase respiration rates? Do different moss species respond differently or will responses be similar? These are some of our main questions regarding moss physiology. We expect that some mosses will benefit more from warming, thereby outcompeting moss species that do less well under warmer conditions.

Our favorite site is Litchfield Island, though it is not without its challenges. A curious skua has been pulling out a particular pair of Plant Root Simulator ® sticks that we use to quantify soil nutrient levels. We keep re-inserting them back in, only to find them strewn about the plot again upon our next visit (see Figure 4). The sites in the Palmer Backyard are fortunately less challenging.

Figure 4- *Left: Despite using camouflage cloth to hide the sticks from prying Skuas, they keep pulling out this particular pair of nutrient sticks (all other sticks are still in the plots). Right: the likely culprit*.

On January 13 we started our temperature incubation in the lab, which complements our field temperature experiment. The goal of lab experiment is to examine warming responses of several species of moss. Given that our field experiment contains communities of diverse moss species, the lab experiment will help in elucidating why carbon fluxes are changing and which of the species are responsible. Who will be the "winners" in a warmer world?

The "control" environmental growth chamber mimics a "typical" daily cycle of summer temperatures in Antarctica. The "warmed" growth chamber is 2°C warmer compared to the control chamber. Hannah James, the summer lab manager, programmed both environmental growth chambers (thanks, Hannah!). The environmental growth chambers are realizing their potential with this experiment! The temperatures I used were based the average daily fluctuation of soil surface temperatures for the month of January that I collected during January 2019 in my pilot study (NSF 1643871; see Figure 5 left panel). Soil surface temperatures are often far higher than air temperatures, whereby mosses can experience temperatures as high as 20 or 30°C. My choice of 2°C warming was because that is within realistic predictions of warming on the Antarctic Peninsula, and it is also the degree of warming realized in the field with the open-top chambers. Hence, we hope to be able to link results from the lab experiment to the field.

For light levels inside the growth chambers, I use high quality aquarium lights (thanks for the advice, Nerissa Fisher, Instrument Tech in the 2022 winter!). These lights are controlled via an iPhone and can be ramped up or down to mimic the sun rising or setting.

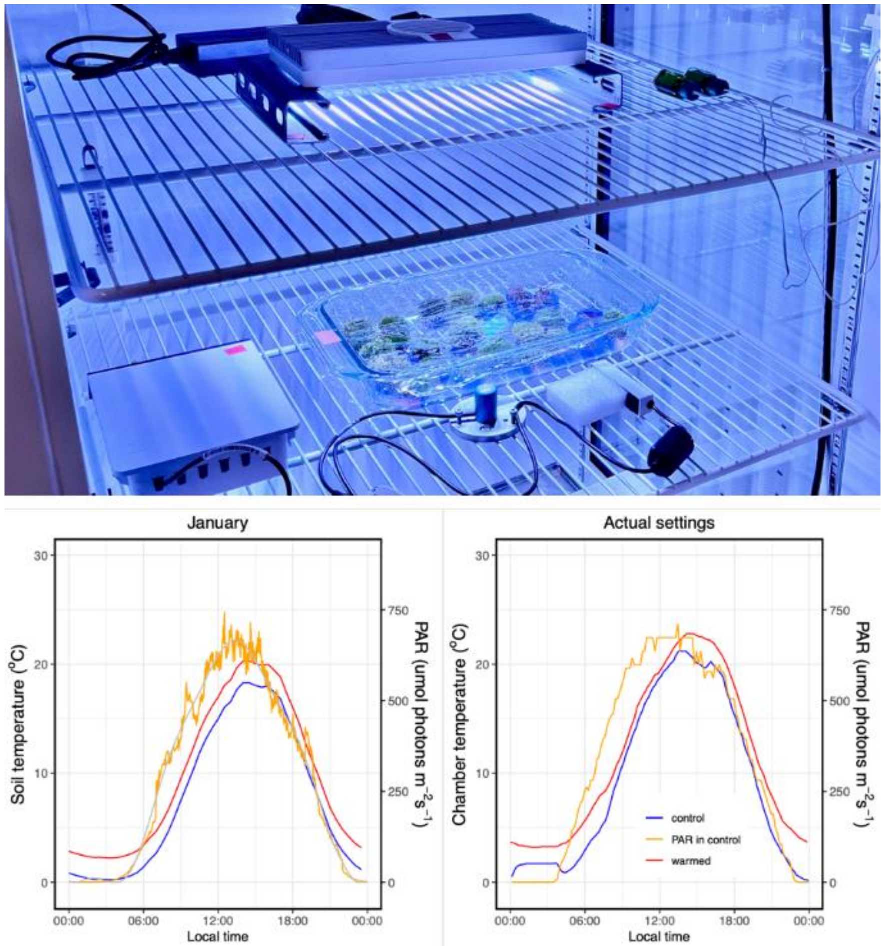


Figure 5- *Top: moss samples inside one of the growth chambers. Thanks for helping to collect them, Hannah James! The aquarium lights, which includes ultraviolet light, can be ramped up or down slowly to mimic sunrise and sunsets. Several sensors monitor light and temperature conditions within the chamber. Bottom left: Average soil surface temperatures over a 24-hour period, based on temperature data from Litchfield (collected as part of NSF 1643871) during January 1 through January 31, 2019. Photosynthetically active radiation (PAR) data are based on the same month in 2019, but collected by Palmer Station (thank you, Marissa Goerke, Palmer Research Associate, for providing the PAR data!). Growth chambers were set to mimic these light and temperature conditions. Bottom right: Actual growth chamber light and temperature settings.*

Outreach/Broader Impacts

I started a blog and an Instagram page when I departed for Antarctica this season. My Antarctic blog (https://www.nvangestel.com/antarctica) has 550 users worldwide, mostly from the US (458), and the remaining mostly from the UK and Netherlands. My Instagram page @AntarcticResearchAdventures (which also links to the blog) has 150 followers and continues to grow.

On January 24 my MS student Sara Bohi and I hosted a "Chat with scientists in Antarctica" Zoom session for schools in the US. Because many schools in Lubbock (where Texas Tech is located) were closed because of a snowstorm that day, we repeated the same presentation again on January 31, with an open invitation to schools across the nations who missed the first one! We had in total 75 participants (most of them classrooms) participating across the US (with schools in TN, TX, NM, CA, MT). Both presentations were advertised by NSF (e.g., https://twitter.com/NSF/status/1620046819844661249?s=20&t=YpSNt7IXHsPP5xVQ6JVkDg).

B-285-P: CAREER: IM-HAPPIER: INVESTIGATING MARINE HETEROTROPHIC ANTARCTIC PROCESSES, PARADIGMS, AND INFERENCES THROUGH EDUCATION AND RESEARCH

Dr. Jeff Bowman, Principal Investigator, Scripps Institution of Oceanography, University of California San Diego
Personnel on station: Jeff Bowman

Project B-285-P continued biweekly sampling in collaboration with the Palmer LTER program for our bacterial grazing experiments. Despite considerable inclement weather we were able make collections from Station E or alternate locations on January 1, 5, 9, 13, 16, 20, 23, and 26. This is an optimal cadence as each experiment takes approximately 72 hours to execute. The inclement weather, loss of RHIB RIGIL, and personnel shortage in the Palmer Station boathouse have created significant challenges for those groups reliant on RHIB HADAR. The boathouse staff continue to operate with an exceptional level of professionalism and dedication to make it work, routinely working late nights and scheduled days off. Because of this extraordinary commitment our group has not lost any science days this month.

We also carried out five experiments with the WOLF cell sorter to determine the taxonomic structure of actively respiring bacterial cells. These experiments involve incubating seawater in the presence of the fluorescent stain Redox Sensor Green (RSG). This stain is converted to its fluorescent form intracellularly in actively respiring cells. By visualizing cells as a function of fluorescence and scatter, we can identify and selectively capture those cells that are actively fluorescing. Because RSG does not harm the cells we are also able to single-cell sort members of the active cell population for culturing and future genomic work.

The RSG stain is much easier to use than traditional measures of respiration. There are currently three groups on station with the ability to measure respiration via four techniques. B-285-P (Bowman) has a manual, optical setup for measuring O_2 drawdown resulting from respiration and the RSG method. C-045-P (Van Mooy) has an automatic optical system based on the same underlying technology as the manual setup. B-086-P (van Gestel) has a LiCOR CO_2 measurement system coupled to an aquatic chamber. We organized a brief cross-calibration experiment on Sunday, January 29th to evaluate these different approaches. A key goal is to see if RSG – by far the easiest technique to implement – can serve as a reasonable measurement of respiration. Analysis of our results is ongoing and will be available soon.

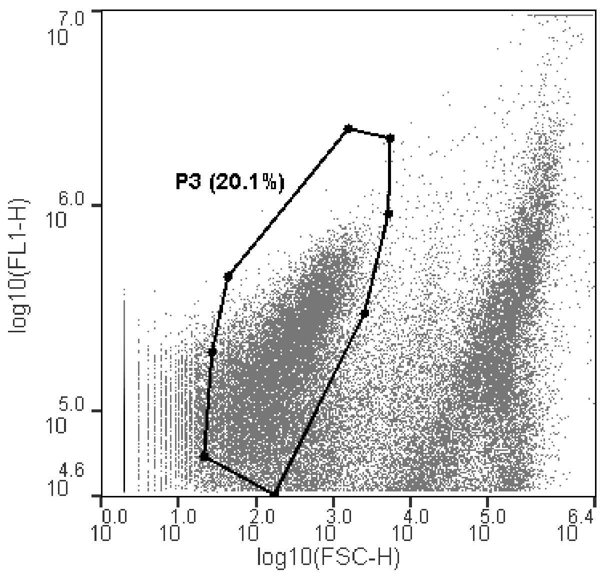


Figure 6- *Arthur Harbor surface water stained with the respiration indicator RSG. The y-axis gives stain intensity for individual cells, while the x-axis is a proxy for size. Each point on the plot is an individual bacterium or eukaryotic cell. We are repeatedly sorting the "P3" region to identify which bacteria are metabolically active across the summer season.*

B-308-P: LINKING PREDATOR BEHAVIOR AND RESOURCE DISTRIBUTIONS: PENGUIN-DIRECTED EXPLORATION OF AN ECOLOGICAL HOTSPOT

Dr. Mark Moline, Principal Investigator, University of Delaware.
Personnel on Station: Erik White, Leila Character, and Matthew Breece

The B-285-P (Moline) group conducted Autonomous Underwater Vehicle (AUV, Figure 7) missions through January to determine the spatial and temporal distributions and density of penguin and forage foods in and around Palmer Canyon. These missions built on the initial sampling done in December, and also did two replicates of the cross-canyon portion of the R/V LAURENCE M. GOULD's EK80 survey. Twenty-four science sampling missions took place during the 2022-23 field season in various environments and conditions (Figure 8).

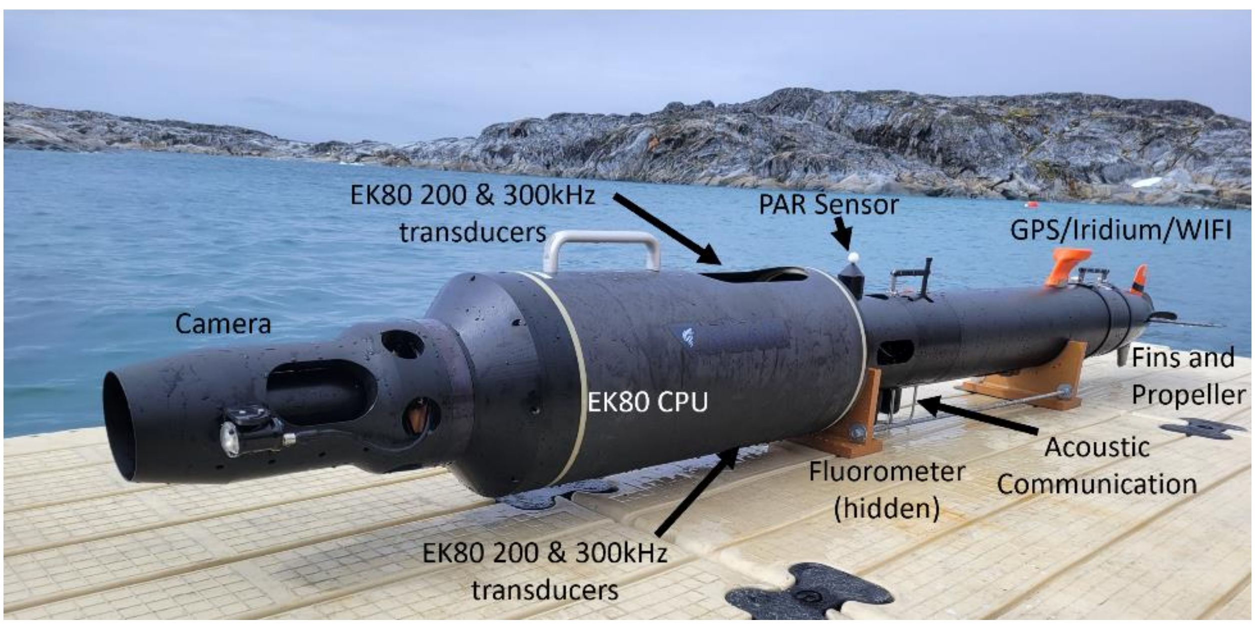


Figure 7- *REMUS Autonomous Underwater Vehicle dockside ready for deployment. Image credit: Matthew Breece*

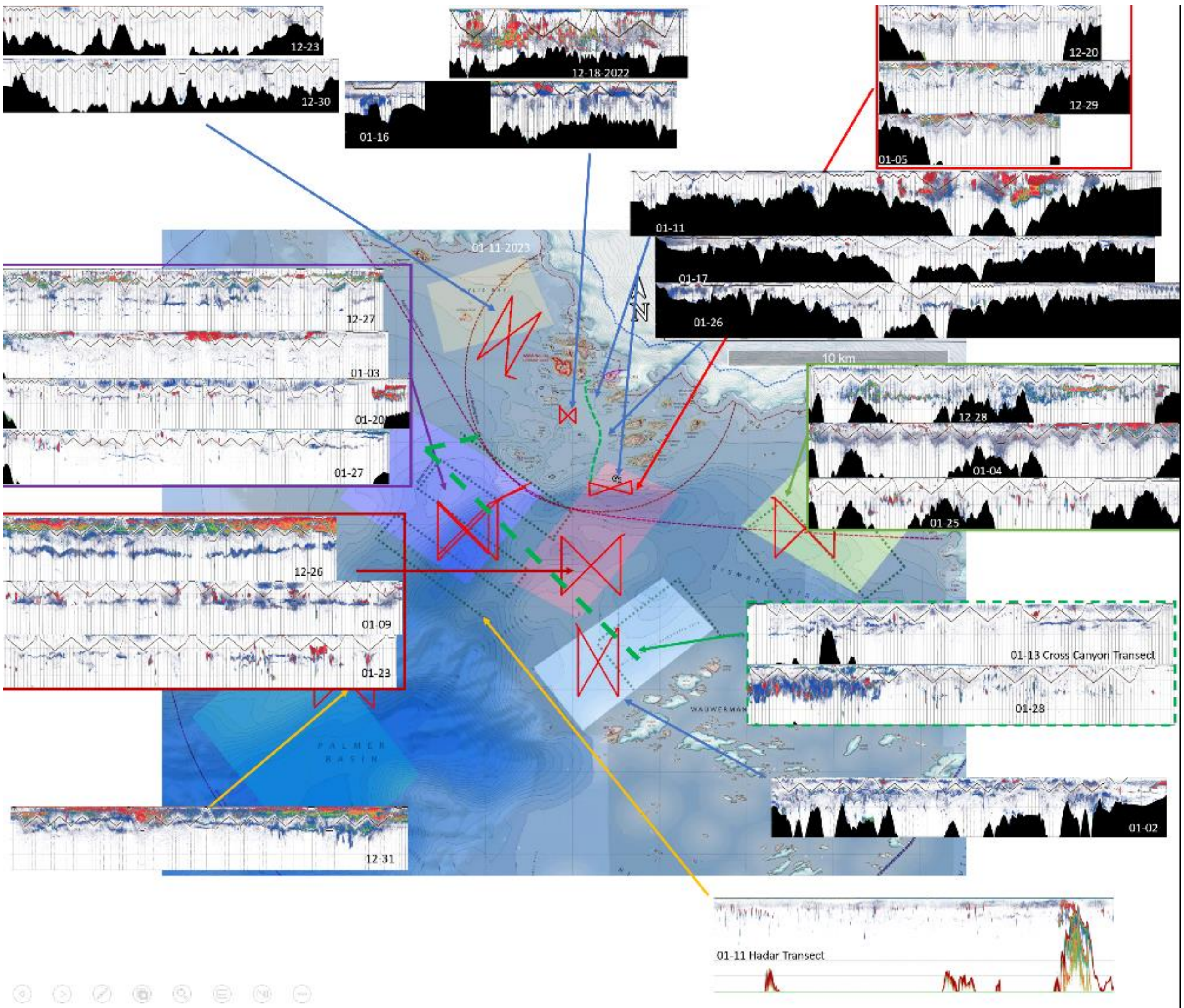


Figure 8- *Map of sampling missions (red bowties) and acoustic data (ribbon plots) of prey surveys during the 2022-23 season.*

Analysis of the video footage from the REMUS along with the acoustic data revealed heavy avoidance of the AUV by krill. This resulted in limited detection of krill in the video frames. As a result, the camera section was removed, allowing for longer duration missions and easier handling of the setup in the Zodiac. Drop camera videos were taken at the point of deployment or retrival of the AUV to visualize organisms and conditions in the water column (Figure 9).

Figure 9- *Screen captures from drop camera lowered during a REMUS mission launch in the Gentoo Transect area (left) and the Station E transect area (right).*

In coordination with C-013 (Cimino) LTER objectives, 22 GPS and/or time-depth recorders were deployed on Adélie penguins and 17 on gentoo penguins. There were 13 video tags put on Adélie penguins with deployments on gentoo penguins planned for the near future. This video footage provides a unique and informative perspective on penguin foraging dynamics (Figure 10).

Figure 10- *Screen capture of video from a tagged Adélie showing active foraging on a swarm of krill. Image credit in collaboration with C-013-P (Cimino) team.*

Field lead, Dr. Breece hosted four Marine Biology classes from Caesar Rodney High School in Camden, Delaware for a video tour of Palmer Station and the project. Students asked questions and got to interact live with a researcher in Antarctica. There were several media groups present and the outreach event resulted in numerous articles, including one produce by the University of Delaware.

https://www.udel.edu/udaily/2023/january/penguins-robots-ocean-antarctica-matthew-breece-carlos-moffatt/
https://whyy.org/articles/delaware-students-zoom-antartica-penguin-research-university-delaware/
https://delawarelive.com/caesar-rodney-climate-class-outta-antarctica/
https://ground.news/article/penguins-robots-the-ocean-and-more

C-013-P: PALMER, ANTARCTICA LONG TERM ECOLOGICAL RESEARCH (LTER): LAND-SHELF-OCEAN CONNECTIVITY, ECOSYSTEM RESILIENCE AND TRANSFORMATION IN A SEA-ICE INFLUENCED PELAGIC ECOSYSTEM, SEABIRD COMPONENT

Dr. Megan Cimino, Principal Investigator, University of California at Santa Cruz.
Personnel on Station: Megan Cimino, Helena Dodge, Darren Roberts

In early January, Megan Roberts and Allison Northey departed on the annual LTER cruise, leaving three birders at Palmer Station for the remainder of the month.

Windy conditions made boating in January challenging. We were able to conduct boating field work on 23 days in January. Monitoring of Adélie, gentoo and chinstrap penguin breeding chronology continued this month with indicator colony counts as well as an all-colony chick census on local islands as well as on Dream and Biscoe Islands. Adélie chick measurements also occurred in conjunction with our LTER cruise team's measurements on Avian Island. Foraging ecology studies of Adélie and gentoo penguins continued this month with the deployment of GPS tags, dive depth recorders, and video camera tags at Torgersen Island, Humble Island, and Biscoe Point. We have deployed a total of 66 tag packages on penguins so far this season. Fourteen of those were radio transmitters that are a part of our presence-absence study. Diet sampling of Adélie and gentoo penguins was conducted several times throughout the month. A full nest census was completed at the Rosenthal Islands towards the end of the month. This is the first time that this census has been completed from station.

Figure 11- *A Southern rockhopper penguin observed in the Rosenthal Islands, very far from its typical breeding range.*

Skua work continued this month documenting hatches and monitoring chick growth of brown skuas on local islands as well as on Dream and Biscoe. We attached GPS tags to two Brown skua adults for the first time in the projects history. South polar skua nesting was also documented on Shortcut Island. Monitoring of the blue-eyed shag colony on Cormorant Island continued this month. In January, we maintained GPS tagging effort on giant petrels and continued our local island giant petrel census and banding project that was initiated in December. Our annual Humble Island giant petrel study began in January, which tracks chick survival and growth from hatching to fledging.

Figure 12- *An adult brown skua with a GPS tag attached.*

Figure 13- *A penguin survey in the Rosenthal Islands ASPA.*

Monitoring of marine mammals continued in January with increasing numbers of Antarctic fur seals documented in the Palmer area. Humpback whales were the most commonly observed cetacean. Lab work this month was dominated by penguin diet sample processing.

ASC support was outstanding this month. The effort to get to the Rosenthal islands would not have been possible had it not been for Andrea Dixon, Hannah James, Chris Borghesani, Barbara Krasinski, and Matt Gosselin. Each one of these people, as well as the ASC and science community in general, were key to our success and we sincerely appreciate the time and effort that everyone put into this evolution. This data provides important baseline and comparative information for our Palmer Station work.

C-019-P: PALMER, ANTARCTICA LONG TERM ECOLOGICAL RESEARCH (LTER): LAND-SHELF-OCEAN CONNECTIVITY, ECOSYSTEM RESILIENCE AND TRANSFORMATION IN A SEA-ICE INFLUENCED PELAGIC ECOSYSTEM, PHYTOPLANKTON COMPONENT

Dr. Oscar Schofield, Principal Investigator, Rutgers University, Institute for Earth, Ocean, and Atmospheric Sciences, Department of Marine and Coastal Sciences
Personnel on station: Quintin Diou-Cass, Sneha Sivaram

January marked a high-paced but interesting month for the Schofield group, with the continuation of our normal sampling schedule and the addition of several light experiments.

January also saw the return of our cruise counterparts as they arrived back into Palmer Station on their way North to South America. The cruise team passed on samples and instruments for the station team to run until the end of the season in mid-March. January also saw the departure of the lab's running lead and authorized radiation user, Quintin, who headed back north with the cruise folks. Sneha has been named lead in the meantime until the newest (and final) arriving member of the Schofield Lab, Michael Chen, arrives in mid-February.

With Quintin's departure, we completed the last of our primary production experiments and shut down the station's radioisotope lab for the summer season. Primary production refers to the amount of carbon taken up by phytoplankton per volume of water per day. To make these measurements, the Schofield lab utilizes radioactive carbon (C_{14}) and 24hr incubations to measure how much carbon the phytoplankton community takes up in one day. This includes taking water from five different depths, placing them in clear glass jars and spiking the contents with radioactive carbon so the phytoplankton can utilize that carbon during growth. Bottles are then placed in mesh bags to replicate the light levels at the depths they were collected, and left in an outdoor flow-through tank to maintain appropriate water temperatures and natural light intensities. Unfortunately, weather and other issues over the season prevented us from collecting about 50% of our planned primary production data. However, preliminary data collected over the season (Figure 14) still shows an expected seasonal trend, where blooms of phytoplankton become greater as the environmental conditions become more favorable for algal growth.

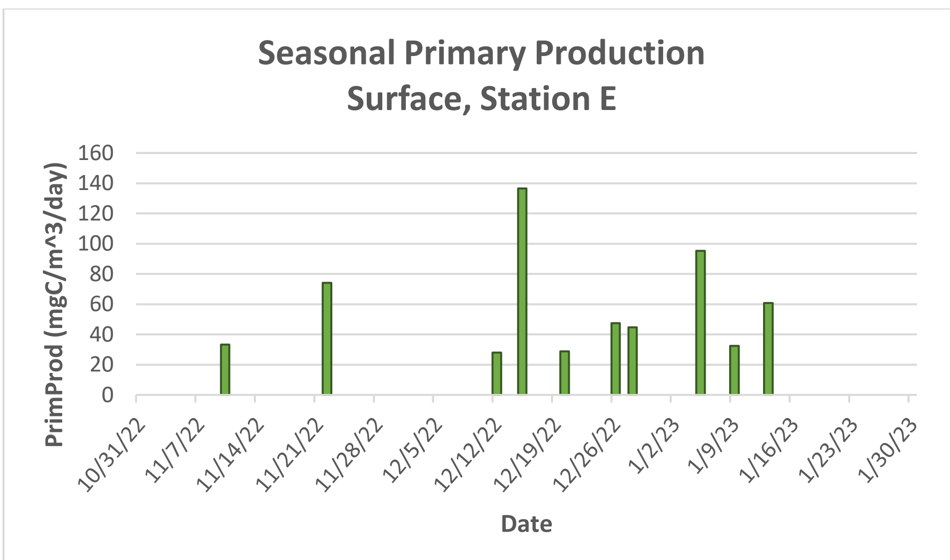


Figure 14- *Bar graph showing surface primary production rates (mgC/m^3/day) between November 2022 and January 2023*

Since the start of November, we have been collecting data from Station E (at the edge of Palmer Deep Canyon) on the state of light energy use and dispersion in the algal communities. In short, phytoplankton have one of three exhaust pathways that they can funnel the light energy they get from the sun. The primary de-excitation pathway is photochemical ($\Phi PSII$), and channels energy into photosynthesis to go towards growth and function. The other two pathways are exhaust pathways for excess light energy; thermal (ΦT) and fluorescence (ΦF). These release any extra energy as heat and light so that the photosynthetic systems do not get overwhelmed when there is a lot of light available. Preliminary data from the surface ocean (Figure 15) shows the monthly average of the three de-excitation pathways for Palmer Deep phytoplankton in the surface ocean.

Over the course of the spring/summer season, only minor changes in the parameters can been seen between the months, but these changes seem to suggest a slight increase in the proportion of thermal dissipation alongside a slight decrease in the proportion of photochemical use. Likewise, an average of all the data collected so far (Figure 16) shows a majority of energy being dissipated as heat, closely rivaled by photochemical use. In either case, fluorescent dissipation is relatively low and unchanging throughout the spring/summer, leaving a majority of the photophysiological changes to a give-and-take between thermal and photochemical dissipation.

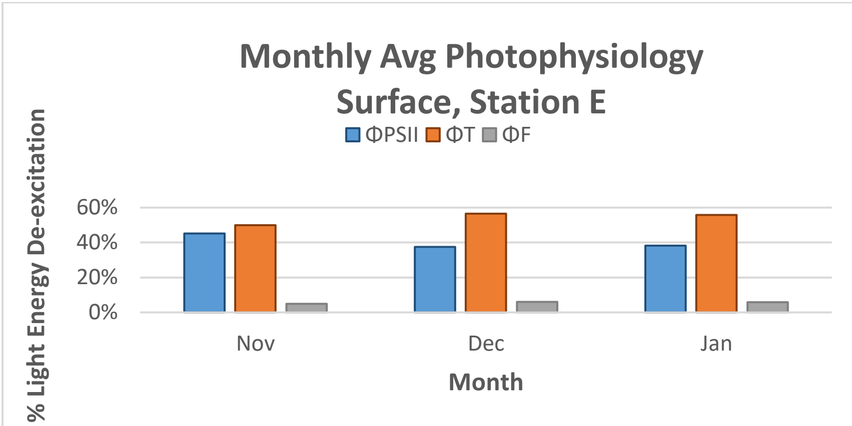


Figure 15- *Bar graph showing monthly averages of de-excitation pathways for surface ocean at Station E for November 2022, December 2022, and January 2023*

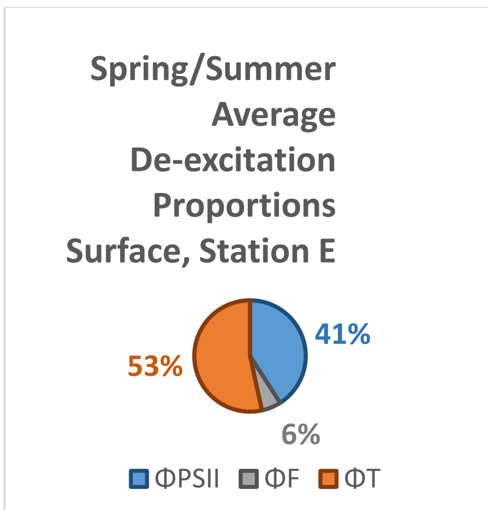


Figure 16- *Pie chart showing the average percent contributions of the three de-excitation pathways in the surface ocean of Station E between November 2022 and January 2023*

Between December and January, we completed four light experiments quantifying photophysiology, community composition, particle size distributions, and pigment proportions on natural communities of algae. Once this data is analyzed, we will be able to quantify the rates at which phytoplankton communities adapt their photosynthetic system to new light environments. Through February, we anticipate completing two more light experiments and will attempt a few new diel experiments. These diel studies will collect information on phytoplankton community photophysiology and composition over a 24hr cycle, collected from Palmer Station's pumphouse on a 2-3hr frequency. This will help tell us the differences in community photophysiology between night and day, which will inform our other sampling schemes and allow us to draw conclusions about the flexibility of Antarctic phytoplankton photosynthesis.

February will be the last full month for the Schofield Lab before the end of our science season in mid-March. We're looking forward to a productive final push to the finish line, and hopefully capture some interesting dynamics/trends in the transition from summer to fall!

C-020-P: PALMER, ANTARCTICA LONG TERM ECOLOGICAL RESEARCH (LTER): LAND-SHELF-OCEAN CONNECTIVITY, ECOSYSTEM RESILIENCE AND TRANSFORMATION IN A SEA-ICE INFLUENCED PELAGIC ECOSYSTEM, ZOOPLANKTON COMPONENT

Dr. Deborah Steinberg, Principle Investigator, Virginia Institute of Marine Science, Department of Biological Oceanography
Personnel currently on station: Andrew Corso

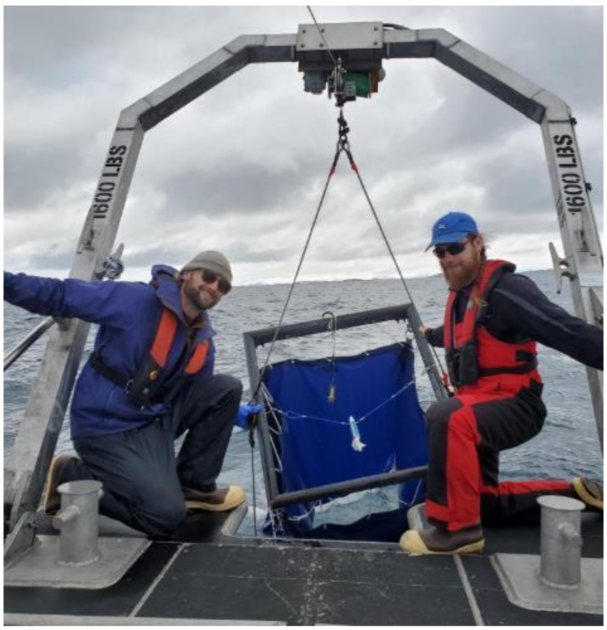


Figure 17- *Andrew Corso and Matt Gosselin (one of the Marine Technicians at Palmer Station) deploying the 1-m2 frame metro net off the stern of Hadar. We are incredibly appreciative of the dedicated support we have received from Matt and the other Marine Tech currently at Palmer (Barb Krasinski). Their efforts have made our science possible! Photo by Sneha Sivaram.*

The Steinberg Lab is excited to return to Palmer Station this January for our 5th season studying the coastal zooplankton community. While the bulk of our lab remains on the ASRV Laurence M. Gould to complete the annual Palmer LTER research cruise, Andrew Corso is conducting pelagic net tows aboard RHIB HADAR. We are deploying 1-m2 frame metro nets to a depth of approximately 50m to collect and study the organisms living in the near-surface layer of the water column, zooplankton. In previous seasons, the zooplankton we commonly capture include krill (*Euphausia superba* and *Thysanoessa macrura*), salps (*Salpa thompsoni*), pteropods (*Limacina helicina*), and several species of copepods. We are interested in how this assemblage grows and changes in structure over the season from the beginning of January through the end of March. In addition to zooplankton abundance and growth, we are also freezing organisms individually to analyze their diet composition. These zooplankton form the central component of the pelagic food web, serving as an important link between lower trophic levels (e.g., diatoms, cryptophytes, and other groups of phytoplankton) and higher trophic levels (e.g., humpback whales, penguins, skuas, and other seabirds).


Figure 18- *A brown skua (Stercorarius antarcticus) eating an Antarctic krill (Euphausia superba) in Arthur Harbor, Palmer Station. Photo by Andrew Corso.*

We plan to deploy net tows twice weekly at Station E; although, this has been one of the stormiest Januarys of the last decade. As a result, we have not been able to get out on the RHIB this month as much as we hoped. With just Andrew on Station, we have also been a little shorthanded. Luckily Helena Dodge with C-013-P (Cimino), Sneha Sivaram with C-019-P (Schofield), volunteers from the B-308-P (Moline) group including, Matt Breece, Leila Character, and Erik White, as well as various ASC staff, have offered continued support to get the tows accomplished. The collaborative community is one of the best aspects of conducting research at Palmer Station.


Figure 19- *An Antarctic krill (Euphausia superba) alive and underwater. The green area behind the eyes is its gut, which is full of recently consumed phytoplankton cells. Photo by Andrew Corso.*

With the exception of 60 Antarctic krill captured in our first week of sampling (Fig 19), the keystone species has been remarkably absent from net tows this month. Based on acoustic data from the B-308 (Moline) group at Palmer Station, it appears the krill abundance peaked in late

December and has been sparsely dispersed over the last month. At the beginning of January, we encountered greater-than-usual abundances of the pteropod *L. helicina* (Fig 20). According to research from a previous graduate student, Dr. Patricia Thibodeau, associated with C-020 (Steinberg), these pelagic sea snails appear to favor seasons with less sea ice. Open water conditions potentially allow *L. helicina* more time to feed on phytoplankton, such as diatoms (Thibodeau et al. 2019; Thibodeau et al. 2022).

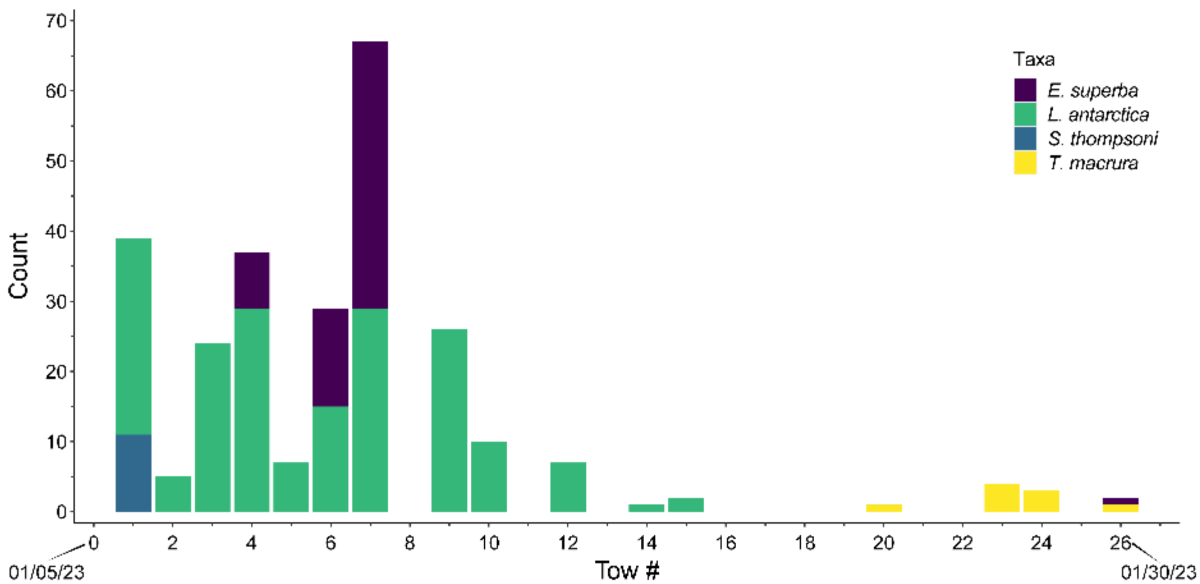


Figure 20- *Taxonomic composition of 1-m2 metro and ring net tows during the month of January. Only the four most abundant species are displayed: Euphausia superba, Limacina antarctica, Salpa thompsoni, and Thysanoessa macrura.*

We are excited to see how this unique zooplankton community changes into the month of February!

C-024-P: PALMER, ANTARCTICA LONG TERM ECOLOGICAL RESEARCH (LTER): LAND-SHELF-OCEAN CONNECTIVITY, ECOSYSTEM RESILIENCE AND TRANSFORMATION IN A SEA-ICE INFLUENCED PELAGIC ECOSYSTEM, WHALE COMPONENT

Dr. Ari Friedlaender, Principal Investigator, University of California, Santa Cruz, Santa Cruz, CA
Personnel currently on station: Ross Nichols and Jenny Allen

Survey Efforts and Data Collection Summary

January marked the start of the 2023 season for the C-024 (Friedlaender) group, with field team members Ross Nichols and Jenny Allen based at Palmer station, while Logan Pallin and Arianna Torello took part in the LTER cruise on the R/V LAURENECE M. GOULD. The group's main research hypotheses are focused on understanding the behavior, ecology, life history and demography of baleen whales in the waters around Palmer Station, and the potential for ecosystem competition and partitioning between baleen whales and other krill predators. The research objectives are addressed through a multi-platform approach, which combines both observational and direct sampling methods. These include visual boat-based surveys, photo-identification, tissue biopsy sampling, drone-derived measurements, passive acoustic recording devices, and animal-borne motion-sensing tags. These data are also integrated with seasonal and oceanographic parameters (*e.g.* krill abundance measured from echosounders). The field team based at Palmer Station conduct research in the station's local and extended boating areas, while the team members on the LMG collect similar data across the LTER oceanographic sampling grid.

The station team conducted daily visual surveys aboard the SOLAS vessel Bellatrix, primarily in the local boating area around Palmer Station. As opportunity permitted, we additionally utilized the extended and distant boating areas whenever possible to expand our spatial range of observation. For each survey we collected photo-ID, biopsies, and drone-derived measurements are collected opportunistically whenever whales are encountered. As of January 30th, we have conducted over 49 hours of surveying across 11 days, during which time we have observed 93 humpback whales (72 non-mother adults, 3 juveniles, 9 mother-calf pairs). We have collected 55 biopsy samples (40 non-mother adults, 4 juveniles, 6 mothers, 5 calves) with 8 additional samples collected by the C-013-P (Cimino) group prior to our arrival. We have 49 individual animal flukes for individual ID (42 non-mother adults, 2 juveniles, 5 mothers), and drone-derived morphometrics for 24 humpback whales. We have not deployed any animal-borne tags from station to date, but we have retrieved 2 tags that were deployed from the team on the LMG. We retrieved two separate passive acoustic moorings, one from south of Torgerson and the other from the Wauwermans. One mooring was redeployed to the Wauwermans, while the other way moved and redeployed near Station H. See summary statistics for sampling in Figure 21.

	Adults	**Juveniles**	**Mothers**	**Calves**	**Total**
Observations	72	3	9	9	93
Photo-IDs	42	2	5	0	49
Biopsies	40	4	6	5	55

Figure 21 *Summary of sightings observations, photo-identification (fluke only), and biopsy sampling. Samplings have been broken down by age class (note that 'Adults' does not include mothers).*

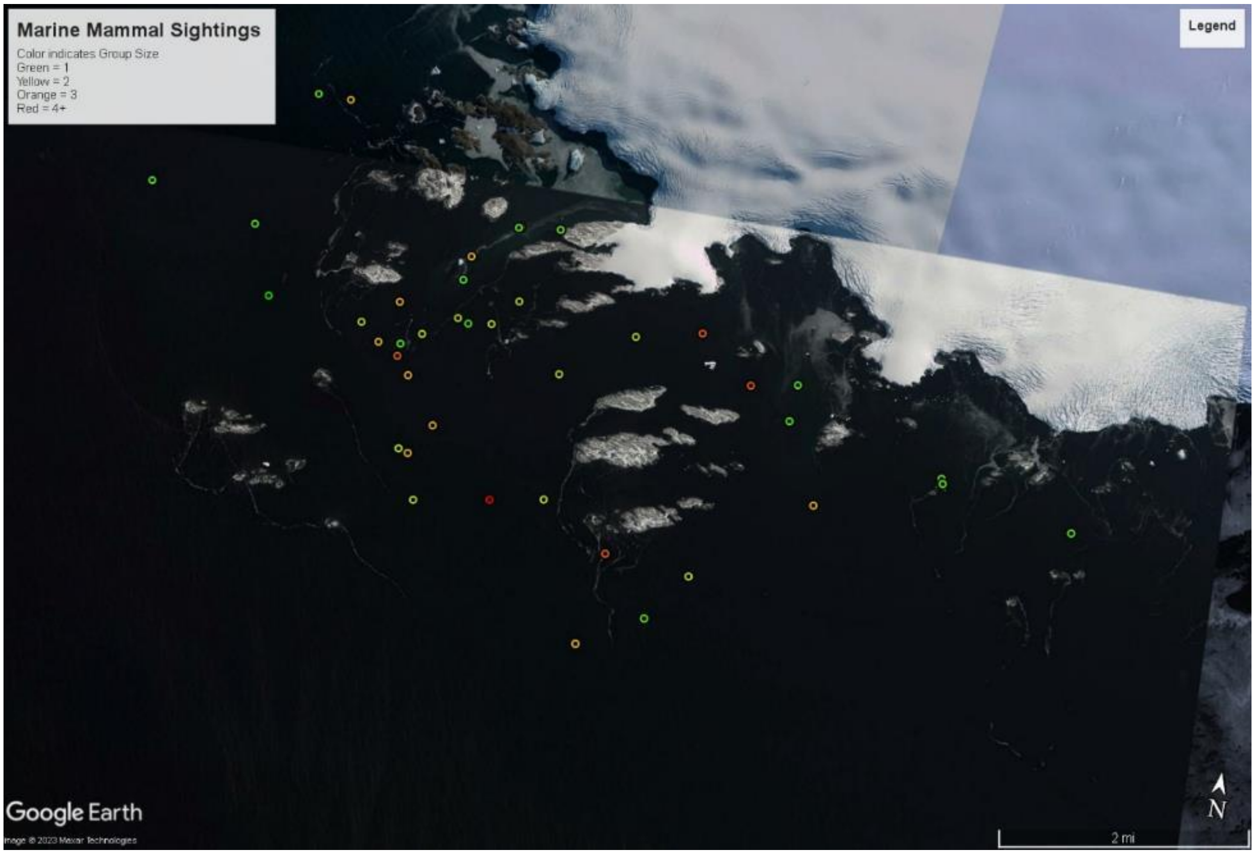


Figure 22- *A map of all humpback whale sightings between January 3rd and January 30th by C-024 (Friedlaender). Color indicates group size, with green representing solo individuals, yellow is groups of 2, orange groups of 3, and red is 4+ individuals.*

Photo-Identification

Photo-identification is done using the markings, scarring, and coloration on the fluke of the animal (Fig. 23). As with previous seasons, there is relatively little site fidelity and low residence times for humpbacks in the Palmer Station survey area, though this is potentially an artifact of the limited size of the survey area. Only 12 individuals were observed in multiple sightings and the vast majority were resighted within 1-2 days. One individual (Mn23_002F_PAL) was resighted 9 days after their initial observation. This matches our general understanding from previous seasons that most humpback whales do not reside within the Palmer Station survey area for extended periods of time. This low residency time is also corroborated by our historic tag data that shows whales using extended spatial areas for feeding during summer months before moving inshore and decreasing their home range sizes towards the end of the feeding season. When individuals were resighted, it was often in association with different individuals than the initial sighting. This is consistent with the fission-fusion social structure typical of baleen whales, which consists of short-term associations that switch frequently.

Figure 23- *A humpback whale fluke photo-ID shot taken during our 2023 surveys, showing clear black and white identifying marks*

Biopsy Tissue Sampling

The biopsy samples (Fig. 24) are collected via crossbows with a specialized bolt. Photo-ID of flukes and dorsal fins are used to ensure that individuals are not double-sampled. These samples typically contain both skin and blubber, are used for a suite of analyses regarding the health, demography, and reproductive rates of baleen whales and respond to the ecological and environmental changes taking place along the Antarctic Peninsula. Skin samples are used for genetic identification and sexing of animals, and to determine the breeding stock of whales sighted around Palmer Station. This is done by comparison of haplotype frequencies with those collected from animals in Southern Hemisphere breeding grounds. Currently, we estimate that ~95% of the whales encountered around Palmer Station are from Breeding Stock G that winters on the west coast of Central and South America. Blubber samples are used for hormone and pollutant detection and analyses. Stress levels are determined using cortisol levels, while pregnancy is determined using progesterone and estrogen levels. Demographic parameters like pregnancy rates will be contextualized relative to interannual variability of regional environmental conditions including sea ice and krill availability to better understand how changes affect the ecology and population dynamics of humpback whales. Blubber is also used to assess the presence of pollutants, specifically persistent organo-pollutants and the presence of endocrine disruptors that may indicate exposure to microplastic pollution.

Figure 24- *Biopsy dart with biopsy visible at the time of sample collection on a humpback whale. Permit ACA2020-016 and NMFS 23095*

UAS Operations

Unoccupied aircraft systems (UASs or drones) are a critical new tool in cetacean research at Palmer Station (and now in all areas where cetaceans are studied). Aerial photography, when paired with precise altitude measurements, enables analysts to measure dimensions of a whale's body with high precision and accuracy (Fig. 25). These measurements contribute to analyses of whale anatomy and physiology, and comparisons across time and space can address broader questions of foraging ecology, phenology and prey consumption in different regions and periods of the feeding season. Occasionally, aerial photography and video can also capture cetacean behaviors that are difficult to discern and describe from observations at sea-level, such as bubble net feeding (Fig. 26), coordinated feeding (Fig. 27), social display behaviors (Fig. 28), and resting (Fig. 29).

UAS operations have been greatly successful this year, with a DJI Inspire 2 being deployed for whale photogrammetry and behavioral observation. In the month of January our team conducted 12 successful UAS flights near Palmer Station and within the Palmer Boating Area: 4 test flights from station and 12 flights for whale photogrammetry and behavioral observation. The whale photogrammetry flights have taken place throughout the local boating area.

Figure 25- *A screenshot from a video collected by a drone that will be used for photogrammetry and measurement of an adult humpback whale. Permit ACA2020-016 and NMFS 23095*

Figure 26- *Three adult humpback whales emerge around a bubble net, captured from a drone at 140 feet. Humpback whales encircle their prey with bubbles before feeding*

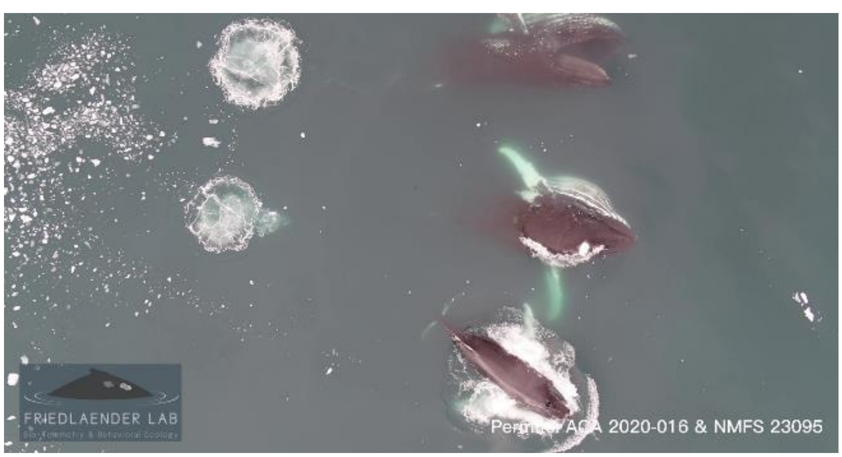


Figure 27- *Three adult humpback whales perform surface 'lunges' together*

Figure 28- *A male adult humpback whale performes an 'inverted fluke slap', a surface display.*

Figure 29- *Two adult humpback whales rest on the ice edge*

Acoustic Moorings

Since 2021, our group has maintained two submerged acoustic moorings around the local and distant Palmer area. Each mooring is equipped with an underwater acoustic recorder (hydrophone), a temperature logger, and an acoustic release. During the month of January, our lab recovered two moorings, which had been recording since April 2022, and deployed two moorings (Figs. 30 & 31). The hydrophones record 60% of the deployment duration and are capable of recording frequencies up to 48 kHz (96kHz sampling rate), well within the range of most vocalizations of humpback whales, minke whales, killer whales, and beaked whales. The goals of these recorders are to measure the acoustic landscape ('soundscape') of the local Palmer area and the greater Palmer canyon. This includes the sounds and vocalizations made by animals, such as whales, seals and birds, but can also include sounds of the abiotic system, including sea ice, storms and glacial calving. Additionally, these moorings will be recording any sources of anthropogenic noise, caused by ship traffic, construction, or sonar. These moorings will help establish the baseline acoustic environment of the Palmer area, and to help identify seasonal whale presence throughout the entire year, and how human disturbance and abiotic factors may influence that acoustic presence.

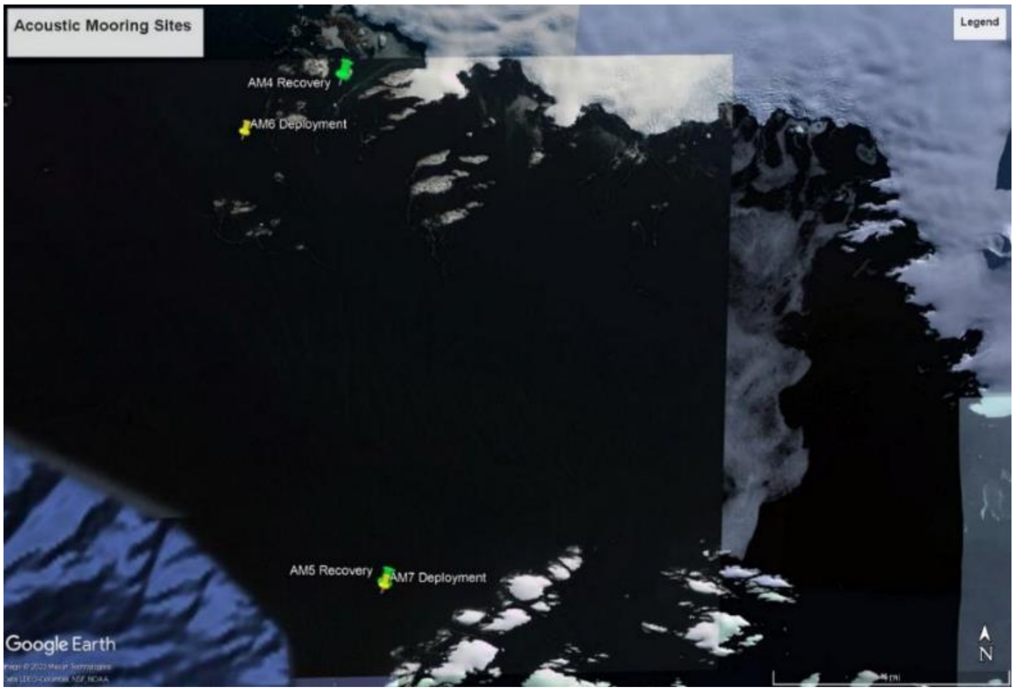


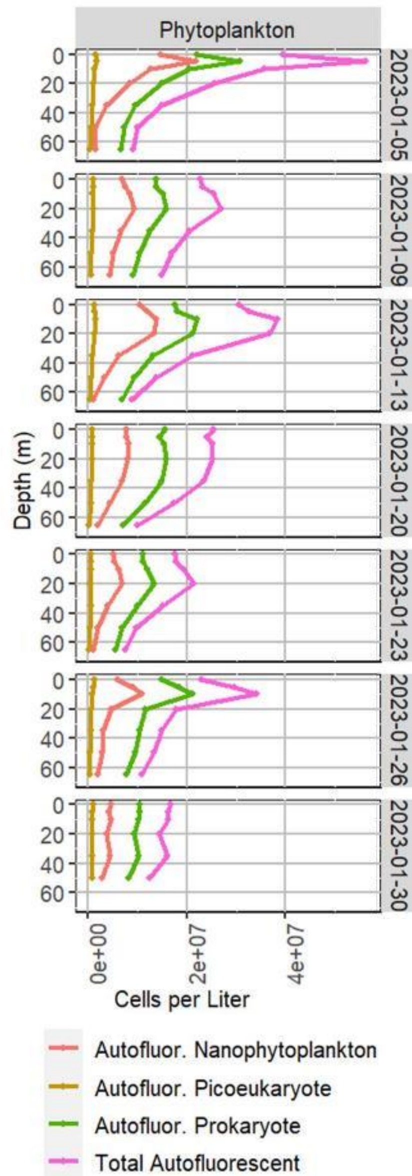
Figure 30 *– January Mooring Recovery and Deployment Locations*

Figure 31 *- AM7 Deployment of Dr. Jenny Allen and Ross Nichols placing the buoy off the side of the SOLAS Bellatrix vessel*

C-045-P: PALMER, ANTARCTIC LONG TERM ECOLOGICAL RESEARCH (LTER): LAND-SHELF-OCEAN CONNECTIVITY, ECOSYSTEM RESILIENCE, AND TRANSFORMATION IN A SEA-ICE INFLUENCE PELAGIC ECOSYSTEM-MICROBIAL, BIOGEOCHEMICAL COMPONENT

Dr. Benjamin Van Mooy, Senior Scientist, Marine Chemistry and Geochemistry, Woods Hole Oceanographic Institution

Personnel on station: Benjamin Van Mooy, Daniel Lowenstein



January was an immensely productive month for C-045-P (Van Mooy). After getting the season off to an amazing start, WHOI Research Assistant Mackenzie Curtice left station at the beginning of January to join the LTER cruise. MIT/WHOI graduate student Daniel Lowenstein and Dr. Benjamin Van Mooy took her place to keep the momentum going. Sampling for analysis of the lipid, carbohydrate, and total carbon content of the planktonic community continued semi-weekly on RHIB HADAR cruises to LTER Station E and daily from the Palmer Station pumphouse. These samples will be analyzed back in the lab at WHOI and the resultant data will be the basis of the collaboration with the Schofield group. In addition, a new set of incubation experiments under controlled light conditions was also initiated, which will complement previous seasons' incubations under natural light conditions. The overall goal of this work is to understand the relationship between light and the production of lipids and carbohydrates by phytoplankon. These classes of biochemicals are energy-rich (i.e., they are high in calories), and we hypothesize that phytoplankton produce the most when they are near the surface on clear days when they receive the most energy from the sun. Since phytoplankton form the base of the food web, carbohydrates and lipids provide fundamental fuel for the entire ecosystem.

Although the results of the analysis back at WHOI will not be known for many months, the data we collect on basic phytoplankton abundances at Station E provide some early insights on the connections between light and phytoplankton (Figure). During the first days of January, conditions were calm and clear, and phytoplankton thrived at the surface. If our hypothesis is correct, then we would expect to find the most lipids and carbohydrates at the beginning of the month.

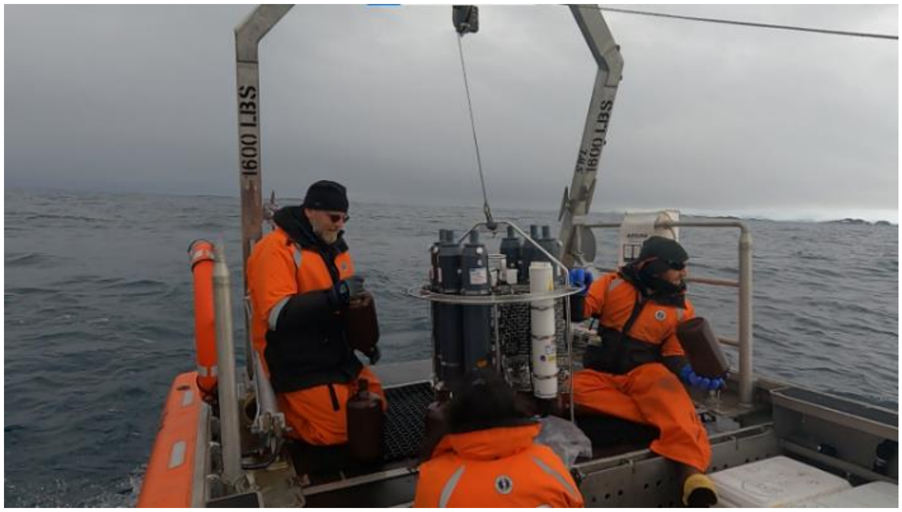


Figure 32- *Van Mooy and Lowenstein on Hadar at LTER Station E collecting plankton samples. Many thanks to Palmer Station Palmer support team for a productive month*

We are also collaborating with the C-013 (Cimino) group to understand the importance of lipids and carbohydrates to penguins. Krill are the primary food source for penguins. They have been shown by other research groups to be very rich in lipids, which originate from phytoplankton that they consume. Furthermore, their exoskeletons are made of carbohydrates. Our goal is to understand how efficiently penguins digest these two classes of biochemicals. To do this the Cimino group is collecting samples on our behalf of penguin diets and feces, for analysis in the lab at WHOI.

PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT
January 2023
Marissa Goerke

Digging out the Wauwermans weather station, January 2, 2023. *Image credit: Marissa Goerke*

A-111-P: THE NEXT GENERATION OF GEOSPACE RESEARCH FACILITIES AT PALMER STATION
Andrew Gerrard, Principal Investigator, New Jersey Institute of Technology

Extremely Low Frequency/Very Low Frequency (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. Lightning source currents are estimated or directly measured by experimental observations of individual natural and rocket–triggered lightning flashes in North America. Together, the North American and Antarctic data sets are used to experimentally identify and analyze the components of lightning and the effects of lightning, such as lightning-induced electron precipitation (LEP), that are observed in the Antarctic, more than 10,000 km away.

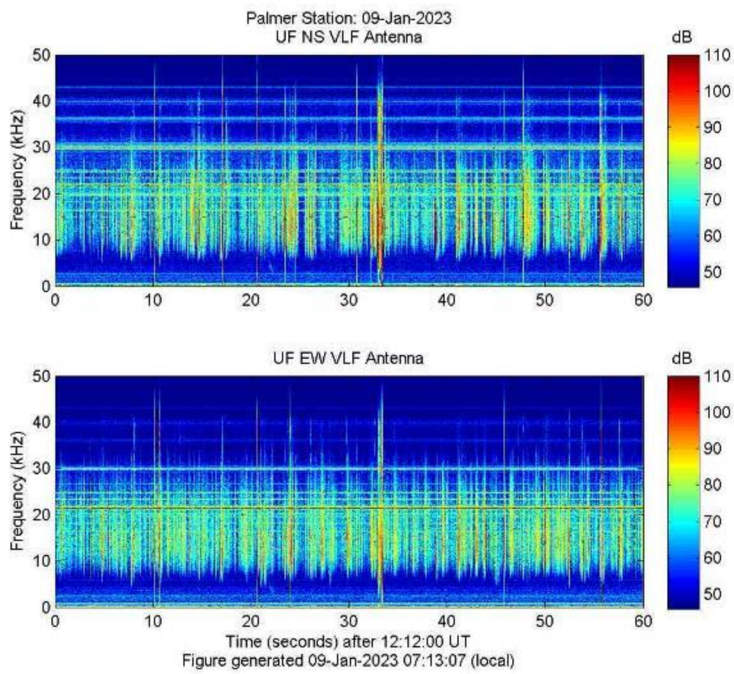


Figure 33. *Real-Time broadband VLF Spectrogram from Palmer Station, Antarctica.*

Both the Extremely Low Frequency and Very Low Frequency systems operated well this month. The spectrograms were reviewed daily and bi-weekly antenna inspections were done as weather allowed.

Current VLF/ELF data from Palmer Station can be observed at:
http://halo.ece.ufl.edu/realtime_palmer_bb.php.

A-111-P: SAMBA MAGNETOMETER
Andrew Gerrard, Principal Investigator, New Jersey Institute of Technology

The three-axis fluxgate magnetometer at Palmer is one in a chain of eleven longitudinal, ground-based magnetometers extending down though South America and into Antarctica. The primary scientific goals are the study of Ultra Low Frequency (ULF) waves and the remote sensing of mass density in the inner magnetosphere during geomagnetically active periods. Palmer's magnetometer is also a conjugate to the Canadian Poste de la Baleine Station, allowing the study of conjugate differences in geomagnetic substorms and general auroral activity.

SAMBA stands for South American Meridional B-field Array. The sites are approximately along the 0° geomagnetic longitude and ranging from -5° to -48° geomagnetic latitude. In combination with other magnetometer chains, including the AGO (Automated Geophysical Observatory) systems elsewhere in Antarctica, the stations create an almost complete, cusp-to-cusp-long meridional chain at approximately 0° magnetic meridian.

The magnetometer was originally installed at Palmer in 2005, and a replacement installed in April of 2008. In 2017 the project was taken over by Andrew Gerrard. On February 27th, 2017 the USAP IT blocked all northbound VPN traffic under a larger umbrella of blocking all northbound encrypted-tunnel traffic. Since that time there has been much discussion, but the magnetometer is still considered a security vulnerability. The Research Associate has been working with the home institution at the University of California, Los Angeles to resolve this issue. As of September 30th, 2020 at 7:45am local time, the magnetometer was removed from the network. The instrumentation and computer are still operational. Data will continue to be collected and stored locally. The RA is working with the IT department to send out the data to UCLA when requested. More information can be found at: http://magnetometers.bc.edu/index.php/palmer.

B-005-P: COASTAL OCEAN DYNAMICS APPLICATIONS RADAR (CODAR)
Josh Kohut, Principal Investigator, Rutgers University Department of Marine

Coastal Ocean Dynamics Applications RADAR (CODAR) was developed between 1973 and 1983 by NOAA's Wave Propagation Laboratory. It is a high frequency radar that operates at 12 MHz so can receive signals from over the horizon. There are CODAR antennas at Palmer (just below Terra Lab near Hero Inlet) and also at the Joubins and the Wauwerman Islands. Each system measures the radial component of ocean wave velocity by transmitting a fundamental frequency at 12 MHz and receiving a reflected signal at twice the fundamental frequency (half the wavelength). By combining the measured velocity components from the three stations, the total wave velocity can be determined. The Doppler shifts of the reflected signals can be used to measure surface currents. Wave velocity can be affected by currents at depths of 1 meter and shallower and thus a measureable with CODAR.

Two of the three sites' transmitter and receivers were shipped north on LMG21-11. The system is still continuously collecting data from the remaining site. The PI has deemed the data useful information from the single site. The Wauwermans site are visited and conditions documented and send to the PI on January 28.

The data will be available in the future at: https://marine.rutgers.edu/~codaradm/.

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

Palmer's seismic station, code named PMSA, is part of the Global Seismic Network (GSN), a collection of 150+ sites worldwide, operating under the aegis of the Incorporated Research

Institutions for Seismology (IRIS), and managed by the United States Geological Survey's Albuquerque Seismological Laboratory (ASL). The site was installed in March 1993. As of August 2006, PMSA is also used as an ancillary seismic system for the CTBT/IMS installation; CTBT-specific protocols for the seismic system are covered in the CTBT (T-998) section this document.

A standard seismic station consists of three seismometers oriented to detect ground motion along three mutually perpendicular lines. Most of the time the directions chosen are north-south, east-west, and up-down. The seismometers in the Palmer Station installation are “forced balanced” instruments, which means that they work by keeping an inertial mass stationary with respect to the instrument (and the earth). When a seismic wave arrives, the ground moves, carrying along the housing of the seismometer. The inertial mass tends to remain stationary and not move with the instrument, but it is electronically “forced” to travel along with the instrument (and the earth). The amount of “force” necessary to make it move with the rest of the instrument is proportional to the ground acceleration and is recorded as the raw data from the seismometer.

By examining time of arrival, azimuth, magnitude, frequency and wave type of the incoming waves, seismologists can determine the location, depth of focus, magnitude, type of faulting that occurred, ground acceleration in gravitational force and the structure of the medium (the earth) through which the waves traveled to reach the station. The Research Associate operates and maintains on-site equipment for the project.

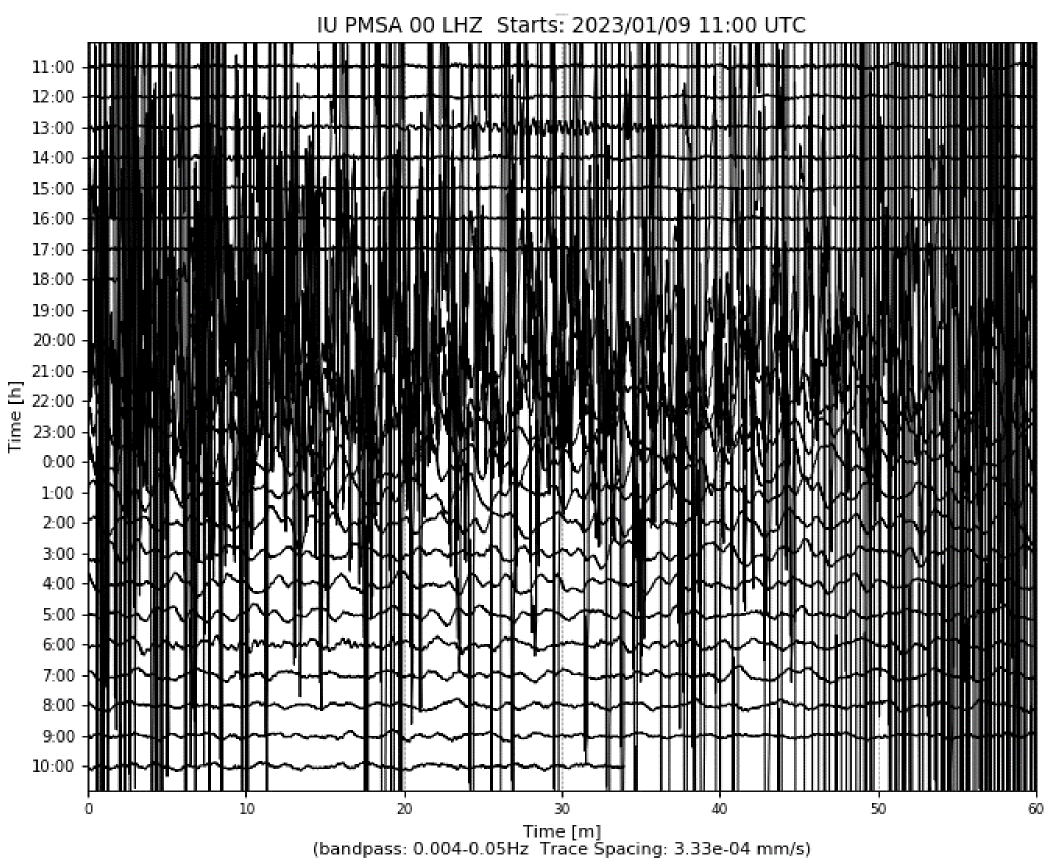


Figure 34- *A 7.6 earthquake on January 10, 2023 in Indonesia as recorded from the Palmer seismic sensor.*

The system operated consistently throughout the month. The time stamp and seismic activity found on the Heliplot was checked daily. Current data from Palmer station can be found on the USGS site: https://earthquake.usgs.gov/monitoring/operations/stations/IU/PMSA/#heliplot.

O-264-P: A STUDY OF ATMOSPHERIC OXYGEN VARIABILITY IN RELATION TO ANNUAL 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 inter-annual 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 Scripps Institution of Oceanography flask sampling project analyzes air samples to assess variations in the atmospheric oxygen content caused by exchanges of O_2 between the atmosphere and the Southern Ocean. The oceans tend to be a source of oxygen to the air in the spring and summer, and a sink for oxygen in the fall and winter. The spring emissions are mostly due to photosynthesis in the water, while the winter uptake is due to mixing processes, which bring oxygen depleted waters from depth up to the surface. These exchanges lead to variations in the oxygen content of the air above the water, and these changes are rapidly mixed around the latitude band by zonal winds. Measurements of the seasonal variations in oxygen content at Palmer and other sites may be valuable for documenting changes in the biological productivity of the southern oceans over time.

The percentage changes in oxygen are very small. Relative to the 20.95% background, the summer-winter differences are only about 0.01%. Some special precautions are necessary so that the O_2 content of the samples isn't perturbed at this low level. Among these precautions are maintaining a constant pressure and temperature in the flasks during sampling. This dictates the installation of the sampling station indoors and the use of a pump module with a bypass valve for avoiding pressure buildup. The Research Associate collects samples fortnightly from Terra Lab.

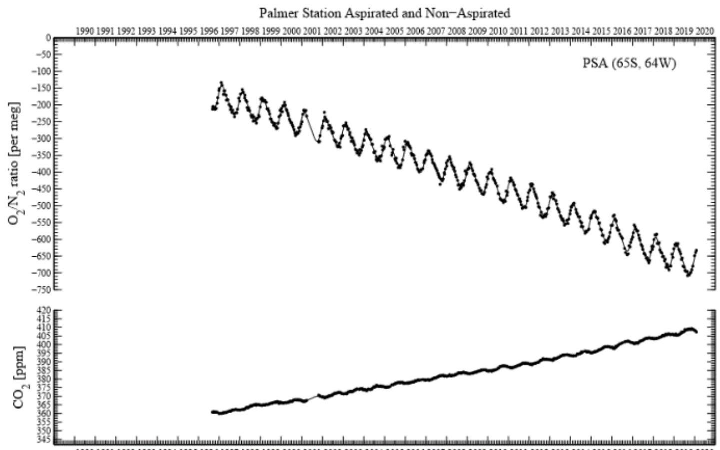


Figure 35 *Historical plot of* O_2/N_2 *ratio per meg and* CO_2 *ppm updated on July 29, 2020.*

Air samples were collected on January 14 and January 31. Wind conditions must equal or exceed 5 knots from a direction between 5° to 205° constantly for over an hour with no interference from human traffic on foot or in vessels. These air samples will be shipped to Scripps Institution of Oceanography in California for analysis. More information and data can be found at: https://scrippso2.ucsd.edu/osub2sub-data.html.

O-264-P: COLLECTION OF ATMOSPHERIC AIR FOR THE NOAA/GMD WORLDWIDE FLASK SAMPLING NETWORK

Don Neff and Steve Montzka, Principal Investigators, 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 (N_2O) and halogen containing compounds. The Research Associate collects weekly air samples for the CCGG group and fortnightly samples for the HATS group. Wind must be between 5 and 15 knots and consistently blow from one sector with no people, equipment, or boats upwind of the sampling location.

Carbon Cycle Greenhouse Gases (CCGG) samples were collected on January 2, January 9, January 16, January 23, and January 30 during favorable wind conditions. More information and data for the Carbon Cycle group can be found at: https://www.esrl.noaa.gov/gmd/ccgg/trends/.

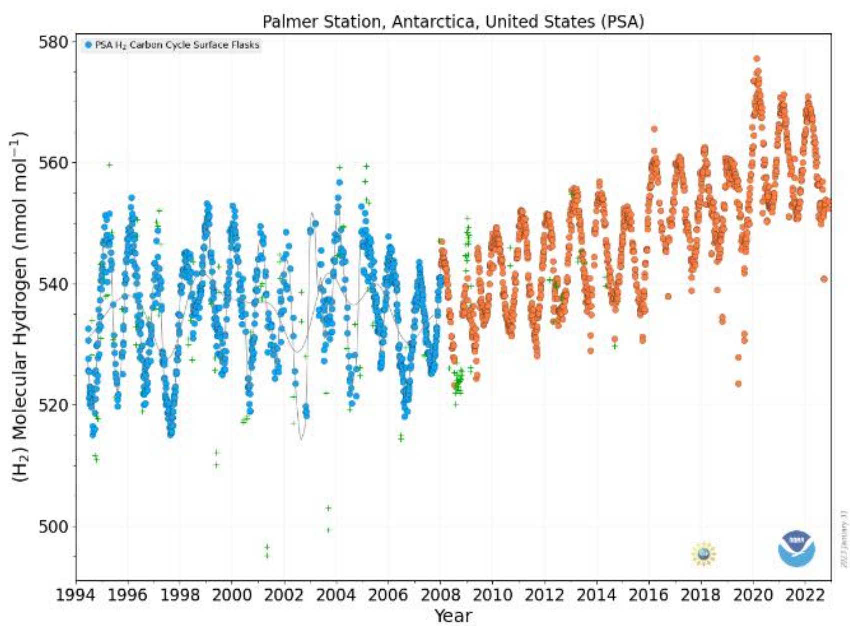


Figure 36- *Molecular hydrogen (H_2) levels at Palmer Station dating back to 1994. Orange dots are preliminary data.*

Halocarbons and other Atmospheric Trace Species (HATS) samples were collected on January 9 and January 24 during favorable wind conditions. Visit https://www.esrl.noaa.gov/gmd/hats/ for more information about the Halocarbons and other Atmospheric Trace Species group.

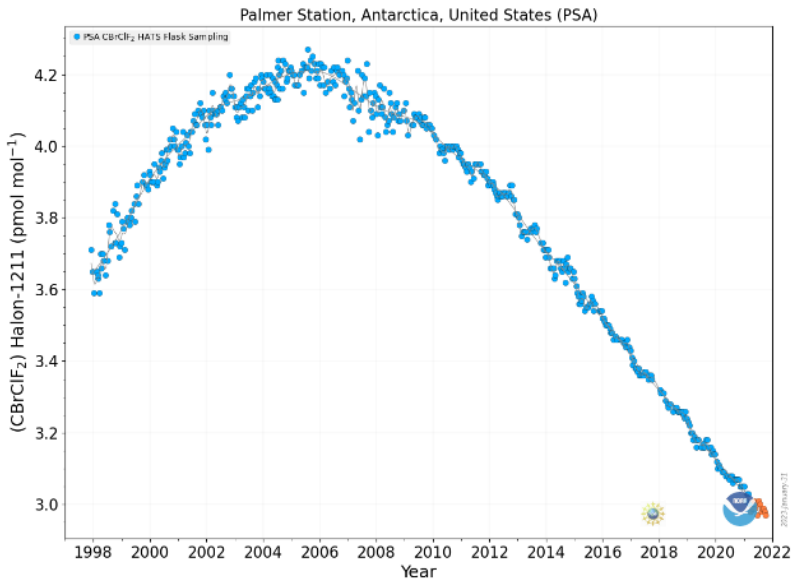


Figure 37 - *Halon-1211 ($CBrClF_2$) levels at Palmer Station dating back to 1997, one of the Halocarbon and Trace Gases measured at Palmer Station.*

All samples collected on station are sent back to the Earth System Research Laboratories in Boulder, Colorado for analysis.

O-264-P: ULTRAVIOLET (UV) SPECTRAL IRRADIANCE MONITORING NETWORK
Scott Stierle, 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 Ground-based Ultraviolet (GUV-511) filter radiometer, an Eppley Precision Spectral Pyranometer (PSP), and an Eppley Total Ultra Violet Radiometer (TUVR) also continuously measure hemispheric solar flux within various spectral ranges. The Research Associate operates and maintains on-site equipment for the project.

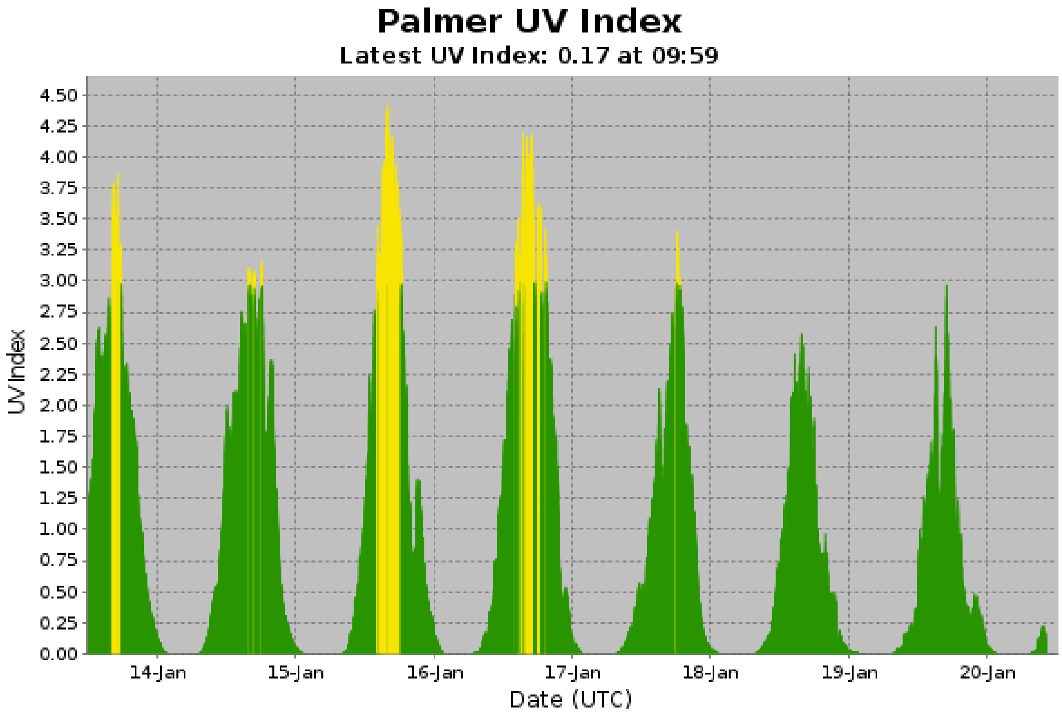


Figure 38- *UV index generated from the GUV-511 radiometer in real time.*

The log was filled out and collectors were cleaned on a daily basis. Once a week level checks were performed to confirm that the instrumentation was within +/- 0.2 degrees. The weekly log was sent out each Monday and bi-weekly SUV-100 UV Absolute Scans were performed on January 14 and January 30 without issues. The highest UV levels for December were reached on January 16 at 4.5 on the UV index.
For more information visit: https://esrl.noaa.gov/gmd/grad/antuv/.

R-938-P: TERASCAN SATELLITE IMAGING SYSTEM
Justin Maughmer, Principal Investigator, System Administrator, United States Antarctic Program

TeraScan is an integrated system of hardware and software designed for automated reception of data from meteorological/environmental satellites and for processing the data into images and data overlays. The system collects, processes, and archives DMSP and NOAA satellite telemetry, capturing approximately 25-30 passes per day. The data files for these images and overlays are of a special format called TeraScan Data Format (TDF). 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.

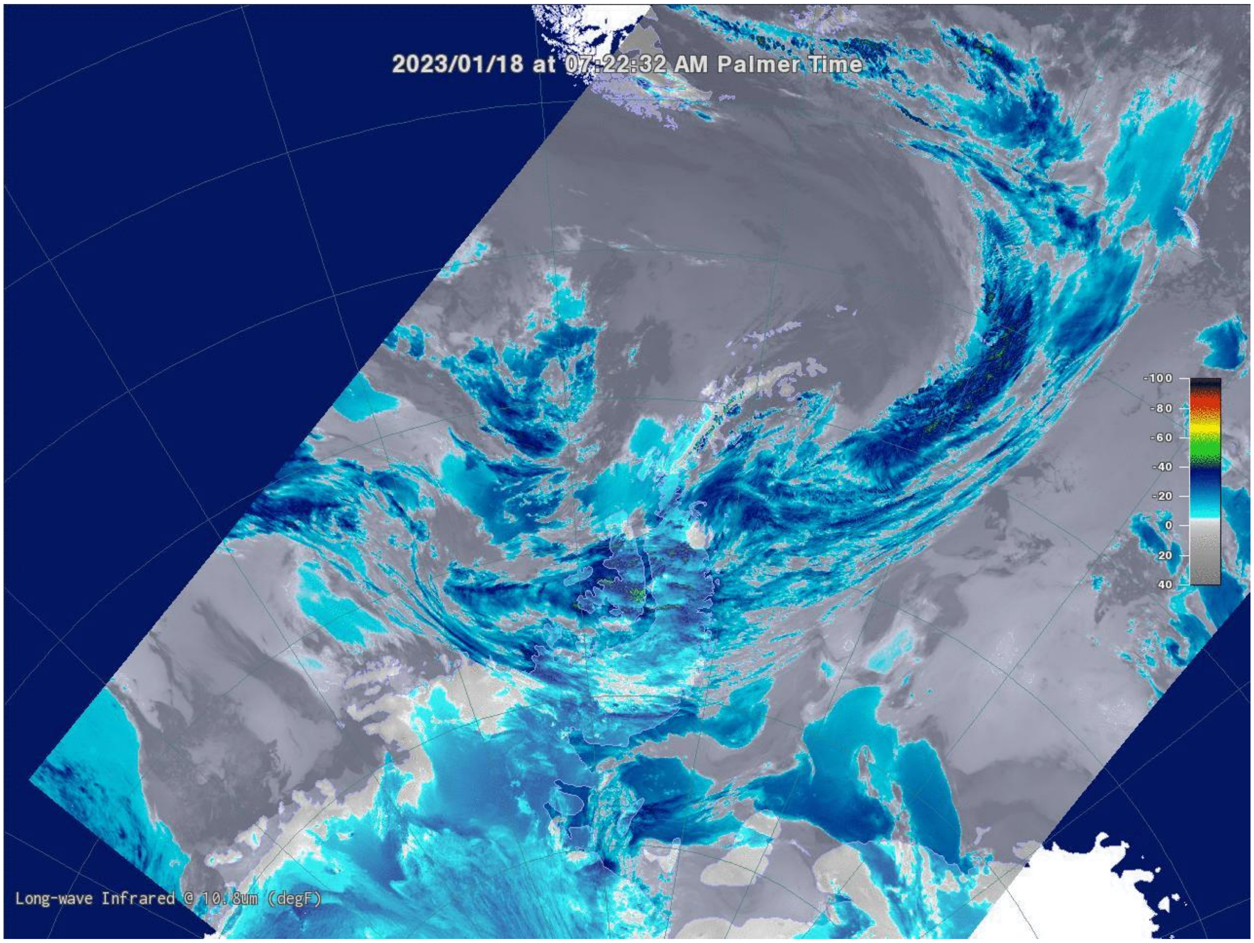


Figure 39- *NOAA-18 January 18 satellite pass which resulted in the month's highest wind speeds.*

The imagery was checked daily. Both the METOP and NOAA satellite passes were captured normally.

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

The National Science Foundation (NSF) tasked and funded the USGS Antarctic Program to establish a GPS (Global Positioning System) Continuous Operation Reference Station (CORS) at Palmer to serve a variety of scientific investigations in Antarctica. A permanent GPS CORS known as PALM (1003) was established during April and early May of 1997. Four reference marks were set and, along with 10 existing survey marks, PALM was tied in by differential GPS methods.

The GPS data collected supports the International GPS Service (IGS). This system is used for global geophysical studies such as crustal motion monitoring and determination of the global frame. PALM also provides Palmer scientists with real-time differential GPS positioning capabilities. Continuous 15-second epoch interval GPS data files are collected at station PALM, compressed, and transmitted to the NASA-JPL in Pasadena, CA.

JPL/NASA is contracted to maintain the system, and they have sub-contracted to UNAVCO. While operation and maintenance of the GPS/CORS base station is the responsibility of the Research Associate, it is available for grantees who wish to use the roving systems and/or differential post-processing using data from the fixed reference station. Users are expected to have proper training prior to deployment to Palmer. The Research Associate may offer support to visiting grantees at their discretion.

The system operated consistently throughout the month. The lights on the Trimble and Septentrio receivers were all illuminated in the correct pattern and showed no signs of interruption. More information can be found at the following website: https://www.unavco.org/projects/project-support/polar/base_stations_and_survey_systems/palmer/base.html.

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

The Comprehensive Nuclear Test Ban Treaty (CTBT) bans all nuclear explosions. Although not ratified, the US is following through with the treaty, including the installation monitoring stations around the world. The global verification regime for monitoring compliance is called the International Monitoring System (IMS). The radionuclide air particulate sampling station was installed at Palmer in October of 2005. Palmer's radionuclide sampler/analyzer (RASA) is a primary station in the IMS, known by its treaty code USP73 (and RN73). The pre-existing USGS seismic system is an auxiliary station, treaty code AS106.

Data collected by Palmer's RASA unit is relayed real-time via a virtual private network (VPN) across the Internet back to the CTBT Organization (CTBTO) in Vienna. As of August 2006, both the RASA and seismic systems have been certified by CTBTO. Palmer is now officially part of the IMS. 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 consistently this month. The RASA GUI was checked daily. The amount of filter material was checked as needed and no anomalies were heard coming from the blower. Daily filters were processed as needed and the monthly log was sent on time. Additional details about the treaty and monitoring stations can be found on the CTBTO web site, http://ctbto.org/.

PHYSICAL OCEANOGRAPHY

Palmer Station has a tide and conductivity gauge located on the west side of the pier at -64.774558° -64.055580° at a height of 11.46 meters (WGS-84). It was reinstalled at this deeper depth after the completion of the Palmer Pier.

The Research Associate acts as the station's physical oceanography observer by maintaining and observing the sea state. Observations of sea ice extent and growth stage is recorded along with continuous tidal height, ocean temperature, and ocean conductivity.

Observations of sea ice around station were made daily.

Tide level, sea water conductivity, and sea water temperature data is archived on the AMRC website: http://amrc.ssec.wisc.edu/data/ftp/pub/palmer/.

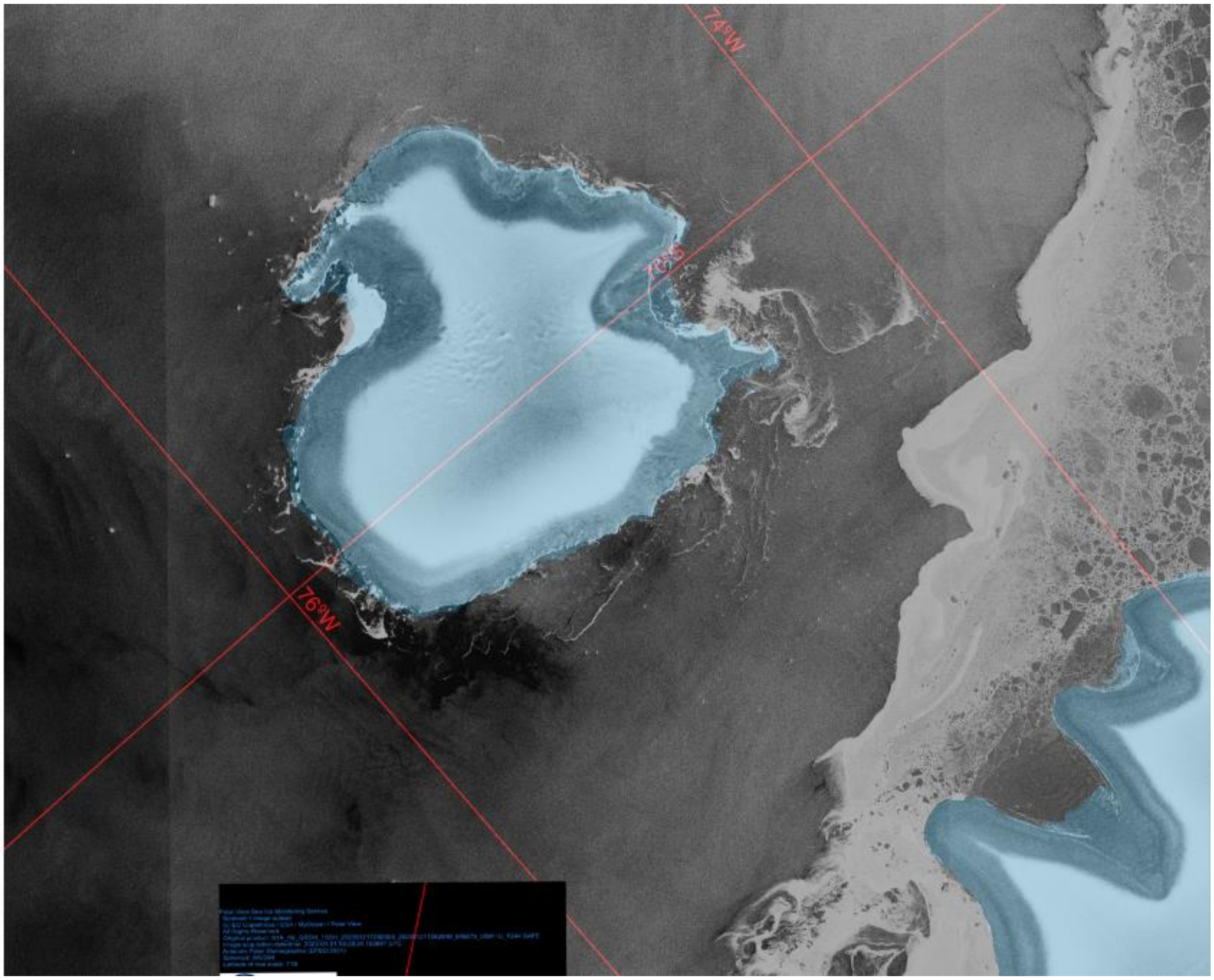


Figure 40 *Charcot Island ice free, January 21, 2022. Source: Polar View*

METEOROLOGY
Mike Carmody, Principal Investigator, United States Antarctic Program

Palmer Station is Station 89061 in the World Meteorological Organization (WMO) Worldwide Network. Automated surface synoptic observations are made 8 times each day and emailed to the National Atmospheric and Oceanographic Administration (NOAA) for entry into the Global Telecommunication System (GTS).

The Palmer Automatic Weather Station (PAWS) is a collection of sensors, computers, and software that records the meteorological data and generates synoptic reports. PAWS began recording data in September of 2015. It was a replacement for the Palmer Meteorological Observing System (PalMOS) that was taken down in November 2017. The PAWS sensors and data acquisition hardware are located on a ridge in the backyard at -64.774130° -64.047440° at an elevation of 38.3 meters above sea level using the World Geodetic System-84. In addition to the synoptic and METAR reporting, PAWS also archives the current conditions at one-minute intervals and displays both raw data and graphs of the sensor data on our local intranet.

The Research Associate acts as Chief Weather Observer on station, measuring, compiling and distributing all meteorological data. Snow accumulation is physically observed by taking an average of five accumulation stakes found near the PAWS system. All weather data is archived locally and forwarded once per month to the University of Wisconsin on the first day of each month for archiving and further distribution.

The local weather station (PAWS) operated well throughout the month. The Wauwermans weather station was visited on January 2 and January 28 and functionality was not restored but was identified as severe corrosion on the antenna. The battery enclosure was removed and replaced with a more waterproof version. A change in weather did not allow for time to replace the antenna. Another visit will be necessary to restore functionality.

Repeated waves of low pressure systems washed into Anvers Island this January resulting in the wettest January on record (since 1990). These low pressure systems kept our average temperatures warm and average wind speeds high. The average wind speed was 13.4 knots, which is almost twice the normal average January wind speed of about 7 knots.

One minute weather data is archived on the AMRC website:
http://amrc.ssec.wisc.edu/data/ftp/pub/palmer/.

Palmer Monthly Met summary for January, 2023

Temperature
Average: 2.8 °C / 37 °F
Maximum: 8.7 °C / 47.66 °F on 24 Jan 18:58
Minimum: -0.3 °C / 31.46 °F on 17 Jan 00:24
Air Pressure
Average: 978.6 mb
Maximum: 996 mb on 10 Jan 23:34
Minimum: 962.4 mb on 29 Jan 07:30
Wind
Average: 13.4 knots / 15.4 mph
Peak (5 Sec Gust): 61 knots / 70 mph on 18 Jan 02:42 from NE (48 deg)
Prevailing Direction for Month: NNE
Surface
Total Rainfall: 121.7 mm / 4.79 in
Total Snowfall: 0 cm / 0 in
Greatest Depth at Snow Stake: 32.2 cm / 12.6 in
WMO Sea Ice Observation: 1-5 bergs, bergy bits, growlers, and brash ice
Average Sea Surface Temperature: 1.66 °C / 35 °F