PALMER STATION MONTHLY SCIENCE REPORT

February 2024

C-013-P (Cimino) birding and C-024-P (Friedlaender) whale research teams stop to chat in Arthur Harbor amongst the brash ice and icebergs. *Image credit: Francis Sheil*

NEWS FROM THE LAB

Hannah James, Summer Laboratory Supervisor

The seasonal shift from summer towards winter has started here at Palmer Station. February was a productive month, though the winds and sea state required a bit more flexibility as the season has begun to turn. However, as anyone who has been to Palmer knows, the resilience of grantees and ASC support staff contributed to another remarkable month of field and lab work. B-046-P (Teets) grantee Cleverson Lima had an incredibly productive month scouring islands throughout our local boating area for midge presence or absence. He provides an excellent round up of his work below. C-013-P (Cimino) and C-024-P (Friedlaender) teams were out on the SOLAS boats every day the weather allowed them, studying the seabirds and whales of our local ecosystems.

Although R/V HADAR was brought back online in mid-January, sadly the boat has been retired for the remainder of the season. On March 1, the same noise that was heard in December on the port engine was heard coming from the remaining starboard engine. The decision was made to pull the mooring in Hero Inlet and trailer the RHIB for the remainder of the season. Boat House staff is looking into the issue further, but hopes are not high that the RHIB will be back out on the water for the final month of Station E sampling or acoustic transects. The Marine Landing Craft was brought online for a sea trial the first week of March. Despite this unfortunate news, R/V HADAR had a very successful February, as the B-285-P (Bowman), C-020-P (Steinberg), and C-045-P (Van Mooy) reports outline below.

I would like to extend a huge thank you to the Boat House staff Barbara Krasinski, Matt Gosselin, David "Goldie" Goldman, and their off-ice supervisor Hannah Gray for all the work they've done to keep our grantees out on the water in each of the platforms we have in our fleet. This season has thrown challenge after challenge at them. I would also like to thank Instrument Technician Lance Roth for all of the work he has put in to ensure that our grantees are able to continue water sampling via small boats, though it may be limited, at Station E.

B-046-P: MECHANISMS OF ADAPTATION TO TERRESTRIAL ANTARCTICA THROUGH COMPARATIVE PHYSIOLOGY AND GENOMICS OF ANTARCTIC AND SUB-ANTARCTIC INSECTS
Dr. Nicholas Teets Principal Investigator, Department of Entomology, University of Kentucky.
Personnel on station: Cleverson Lima

February was a big month for fieldwork. *Belgica antarctica* have been heavily studied for over 60 years now, including by scientists at Palmer Station. Much is known about their physiology, genetics, and phenology (i.e., how their biological cycles work and respond to environmental change). However, there is little to no evidence of how they disperse and establish in new islands given that they have low mobility as larvae (stage where they spend 98% of their lifecycle at) and live as adults for only up to two weeks. In addition to that, animals from this species are flightless, but they somehow colonized islands that have massive geographical barriers that separate one from another (i.e., the sea) and spread through these islands despite the challenging geographical structures that they might present. To shed some light on this problem, we sampled different populations from Cormorant Island and 26 other islands around Palmer Station to help us better understand the patterns of genetic diversification and dynamics of movement of this species.

B. antarctica might be an opportunistic species that relies on birds carrying bits of moss, soil, and shells from one island to another to build their nests, which might be the main contributor for their spread. More locally, besides bird and mammal movements within one island, short bursts and prolonged events of high-speed wind might be important for expanding this species habitat. In addition, human activity, especially tourism, that have been increasing at alarming levels in the past few decades, could be contributing to their dispersal.

Figure 1- Typical habitat for *Belgica antarctica* (the soil under moss and algae). The larvae feed on microorganisms such as bacteria and yeast that compose the microbiome in the soil, and organic material from mammal and bird wastes. *Image credit: Cleverson Lima*

In cases of populations from different islands, once these populations are separated by non-viable habitat (sea or ice), we hypothesize that differences in gene flow might occur, which would lead to genomic diversity that is selected based on different levels of environmental stressors specific for each island (e.g., a population that experience higher exposure to sunlight could respond better to stressful levels of heat, which would explain why we sometimes observe differences in response to similar levels of stress in animals from different

islands - such as the ones that I showed in the previous monthly report). In addition, since these animals are so sensitive to environmental change (including rapid events of variation in environmental conditions), localized microhabitats could be selecting for physiological diversity. Because some microhabitats are covered by snow and ice for longer periods of time (e.g., when they are exposed to less sunlight), organisms that take longer to thaw (or get stuck in puddles of water) might experience a delayed development given the lower amount of time spent in an active lifecycle phase. These specific situations might require special local adaptations to cope with a challenging microhabitat, including a longer lifespan or the need to be more resistance to stress, which could potentially increase genomic diversity within a small range of land.

Considering all these different scenarios, we will genotype samples from 60 different microhabitats from Cormorant Island, and samples from 26 other islands around Palmer Station to look into the genetic history, structure, and gene flow of populations separated by major geographical barriers (e.g., the sea) and local geographical barriers (e.g., hills, rocks, and cliffs).

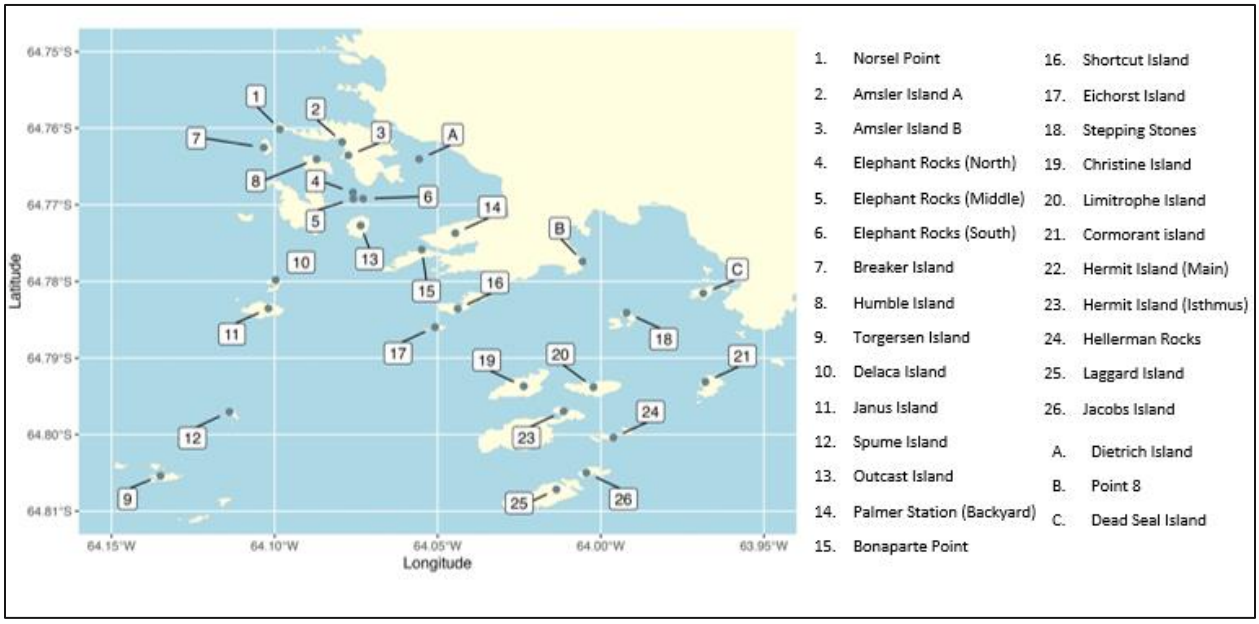

Figure 2- Map of the vicinity of Palmer Station showing the islands visited for this study. Letters indicate islands that *B. antarctica* was not found, and numbers indicate islands where samples were collected.

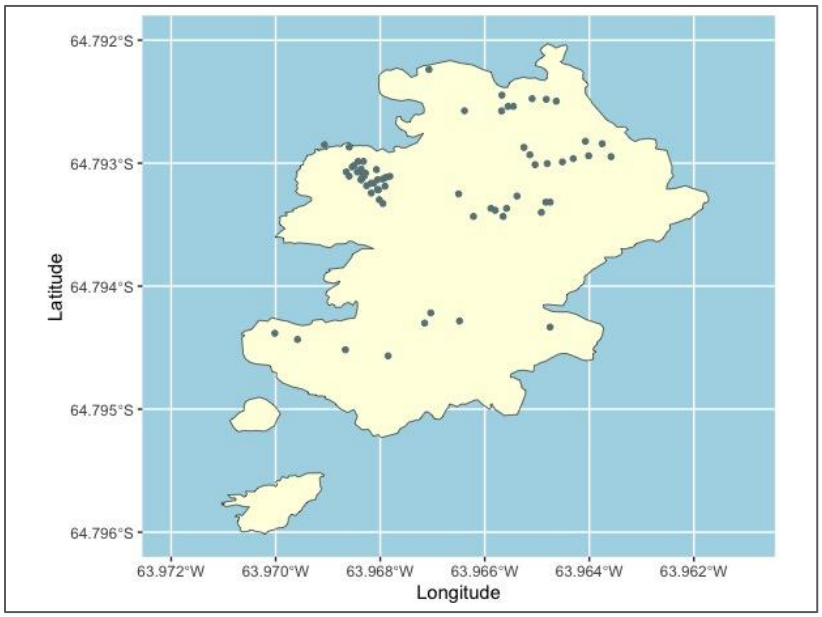

Figure 3- Map of Cormorant Island showing the locations where samples were collected. Although the map does not show elevation or other land structure details, sampling points were chosen considering potential geographical barriers that showed the potential to isolate populations from each other.

As we were carrying out the field collections, we observed that the soil of islands that were recently exposed due to the retraction of the glacier substantially differ from the soil in other islands (Fig. 4A, 4B), which might be a reason for the absence of midges on three of the 29 islands that were visited. Although we found lower arthropods, such as springtails and mites at Point 8 and Dead Seal Island, we were not able to find any trace of *B. antarctica*. In addition, we found adult midges on many islands, including Cormorant Island, which was an interesting event given how late we are in the austral summer. Although some of the adults were found in locations that they have been observed before, we also found them in locations that were recently exposed from thawed snow and ice, and the delay in experiencing viable conditions for reproduction might explain their presence this late in the season.

Figure 4- 4A, Left: Soil under moss found in islands recently exposed by the glacier. 4B, Right: Typical soil that *B. antarctica* is found. They can live as larvae (dark purple spots in the substrate) for over 2 years, and during this period their size can reach up to 0.5cm in length. *Image credits: Cleverson Lima*

Our previous field season was marked by a five-week cruise along the Peninsula, where we collected samples from over 30 islands within a 500-mile range. This season brought us the opportunity to be around these animals in the summer from begining to end. The combination of both allowed us to observe in more details how they move within and between islands, as well as differences in their biology that could be caused from local selective pressures driven by specific characteristics of the island that they inhabit. *Belgica antarctica* is the only terrestrial species of

insect that is endemic to Antarctica. This is the only species of insect capable of thriving throughout millions of years of geographical and climate change, including the last glacial maximum (450,000 years ago), which conferred this species position of the biggest land animal in the continent. *Belgica antarctica* is a key species that can help us understand many biological processes that allow a species to adapt to extreme environmental conditions and provide cues to the phylogeographic history of Antarctica, and we expect that this work will enlighten many questions that have yet to be answered about this unique species and where they inhabit.

Figure 5- Photo register of our team after completion of the Cormorant Island study day, which ASC fondly called "Midgeapalooza." From left to right: Brittni Driver, Cleverson Lima, Alex Mendelson, Hannah James, Amy Varga, and Hector Plaza. *Image Credit- Brittni Driver*

I want to acknowledge the assistance of all Palmer personnel involved in this massive, unprecedented experiment, including Station Science Lead and C-013-P PI, Dr. Megan Cimino for casually mentioning details about Antarctic bird behaviors that turned to be critical for the evolution of this study. Special thanks to Lab Manager Hannah James for the assistance on planning the schedule of the study and organizing volunteers for each day of fieldwork.

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 currently on station: none (work performed by ASC staff)

The specific goal of this project is to study how warming affects the carbon cycle in Antarctica; specifically, how warming affects carbon entering (i.e., via photosynthesis) and leaving (i.e., via respiration) the land ecosystem. The major players in the carbon cycle of the western Antarctic

Figure 6- Open top chamber installed on Litchfield Island. Permit ACA 2023-007. *Image credit Hannah James*

Peninsula are plants and microbes. A major strength of the Palmer Station environs is that the receding Marr Ice Piedmont glacier conveniently provides for a successional gradient, such that we can examine warming-induced changes to the carbon balance as we shift from a solely microbial dominated system (close to the glacier edge) to a fully vegetated system: the moss peatbanks of Litchfield Island.

This year, because of logistical challenges, our field experiment was continued thanks to ASC staff who deployed the open-top chambers along the successional gradient. Chambers were deployed as soon as the areas became snow-free, in January 2024. Open Topped Chambers on Litchfield Island are accessed with permit ACA 2023-007. All 40 field plots contain TEROS12 sensors inserted perpendicular into the soil (0-5 cm) that are linked to a ZL6 data logger (METER Group, Inc, Pullman, WA).

These open-top chambers and TEROS12 sensors were checked after high wind events to ensure that the chambers remained staked to the ground and that the sensor probes were still fully emerged in the soil. The chambers will be removed mid-March, before snow really starts to accumulate at the sites. Batteries will be swapped to power the dataloggers throughout the winter (rather than relying on rechargeable batteries used in conjunction with small solar panels in the summer), and data will be downloaded and sent to the PI towards the end of March.

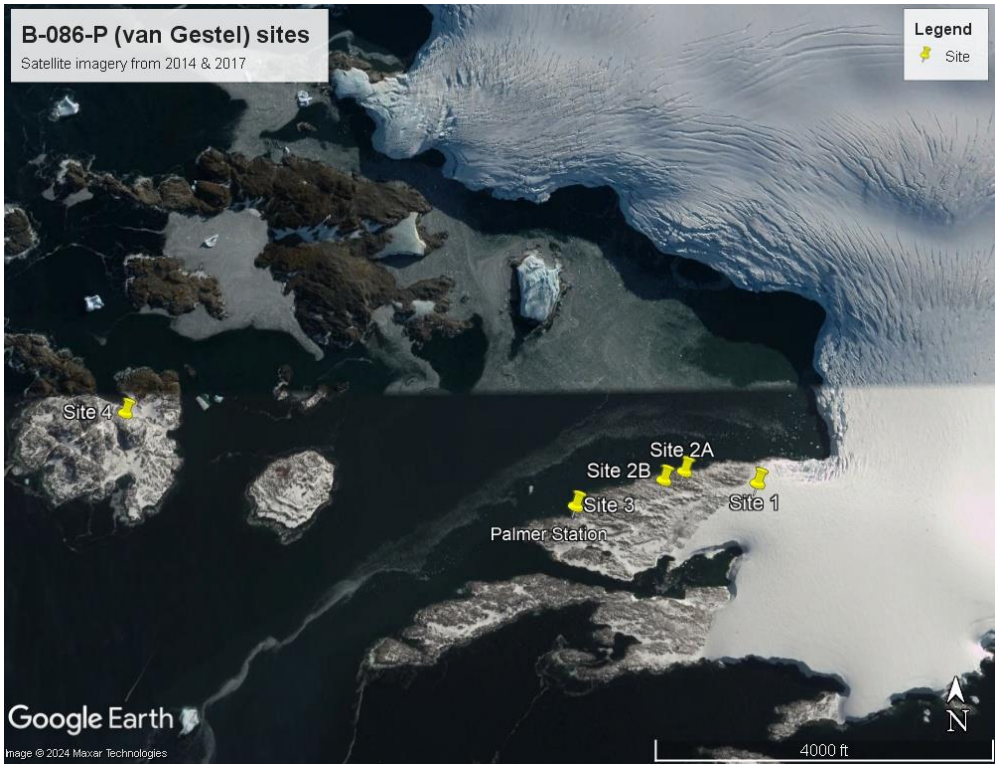

Figure 7- B-086-P (van Gestel) site locations. Google Earth satellite imagery taken in 2014 and 2017. *Figure credit Hannah James*.

B-285-P: UNDERSTANDING MICROBIAL HETEROTROPHIC PROCESSES IN COASTAL ANTARCTIC WATERS

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

B-285-P (Bowman) had a productive month of environmental sampling and experiments. This past month, we were successful at retrieving seawater from Station E on seven occasions: February 1, 7, 10, 12, 16, 20 and 26. We were able to successfully perform experiments on these days with water from the mixed layer (10 m), near the subsurface chlorophyll max (30 m) and below the mixed layer (50 m). At each depth we took initial measurements for bacterial abundance and community structure, then we used the remaining water to perform live experiments to monitor microbial dynamics to infer carbon flow through microbial food webs. The most important of these experiments for our group is a dilution series, where water from 10 m is first filtered either by only a 0.2um filter to remove large grazers or filtered by a tangential flow filter (TFF, pore size 30kDa) to remove viruses. These two types of filtered water are then combined with unfiltered seawater at different concentrations in two (30kDa or 0.2um filtered) series (0% whole water, 30% whole water with either 70% 0.2 or TFF filtered water etc).The dilution series is incubated at 2C for 24 hours, and we use our measurements to determine the influence of both protists and viruses on bacterial growth rate. Obtaining a better understanding of the influence of predation on bacterial growth is critical to understand microbial carbon flow along the wAP as it is currently very poorly understood.

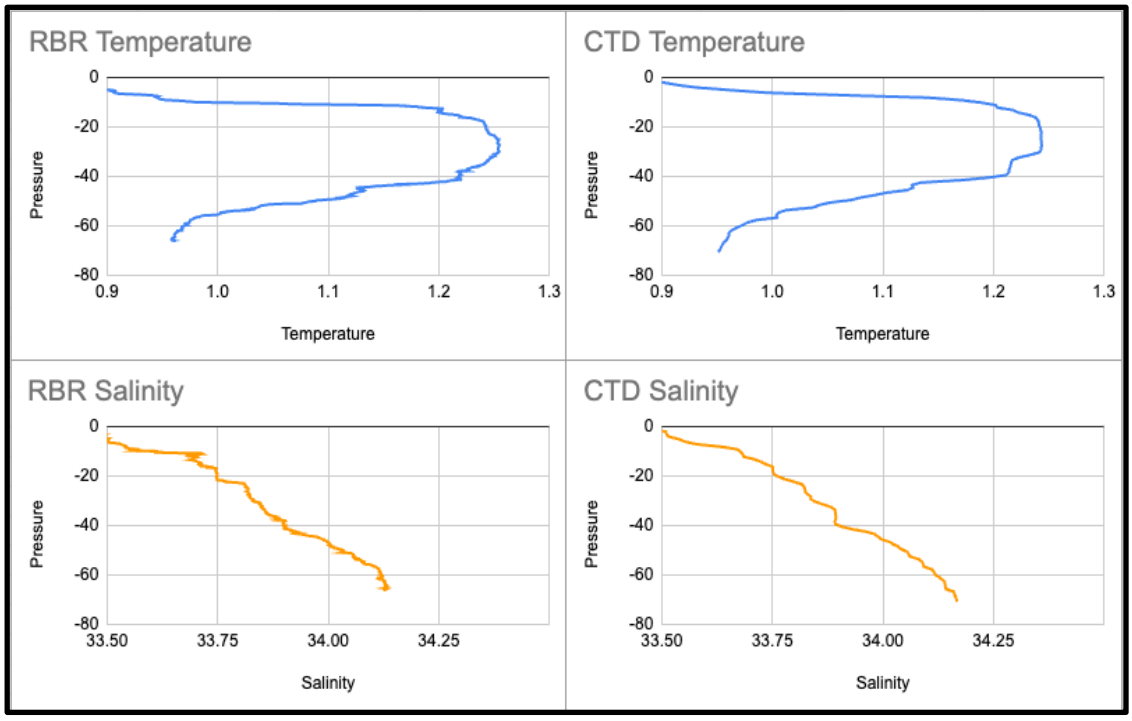

Figure 8- Successful cross-calibration of our two CTD (Conductivity, Temperature and Depth) instruments. The RBR (left) is a handheld CTD that only measures temperature and salinity. We use it from the Zodiacs and on the acoustic transects. The CTD (right) is the instrument we use as part of the sampling rosette we use to collect water at Station E from RHIB HADAR. Alongside temperature and salinity from this CTD, the rosette of instruments includes sensors for beam transmission, chlorophyll, and PAR (photosynthetic active radiation). We deployed both at the same time on February 21, 2024, and both recorded very similar temperatures and salinity over the depth of the water column (pressure is a proxy for depth on y-axis of these graphs). *Figure courtesy of Beth Connors.*

In addition to undertaking the sampling for our lab, PhD student Beth Connors successfully took over sampling for the C-019-P (Schofield) phytoplankton group with the help of C-045-P (Van Mooy) grantee Shavonna Bent this month. For the C-019-P (Schofield) lab, Shavonna and Beth have taken nearly 200 total samples for chlorophyll, phytoplankton pigment analysis (via high performance liquid chromatography), cell imaging (via an imaging flow cytobot) and community structure (via 18S amplicon sequencing). They were able to cross-calibrate the two CTD instruments, which measure Conductivity, Temperature and Depth with great agreement (Figure 6). They also performed a successful calibration of the EK80, the echo sounder used for krill surveys by C-019-P (Schofield) and C-013-P (Cimino).

C-013-P: PALMER, ANTARCTICA LONG TERM ECOLOGICAL RESEARCH (PAL-LTER): ECOLOGICAL RESPONSE TO "PRESS-PULSE" DISTURBANCES ALONG A RAPIDLY CHANGING WEST ANTARCTIC PENINSULA
Dr. Megan Cimino, Principal Investigator, University of California at Santa Cruz.
Personnel on Station: Megan Cimino and Allison Northey.

Favorable weather allowed us to conduct boating field work on 24 days in February. Adélie penguin studies concluded this month with counts and measurements of Adélie fledglings. Adélie penguin foraging ecology studies were also concluded in February with the completion of our radio transmitter study on Humble Island. Satellite tagging of penguins and giant petrels and penguin diet studies concluded this month. Gentoo penguin fledgling measurements on Biscoe Island and in the Joubin Islands were conducted in February and will continue into March.

Figure 9- An Adélie penguin colony starts to thin out as chicks begin fledging. *Image Credit: Megan Cimino*

Skua work continued through February with monitoring and banding of brown skua chicks on local islands as well as on Dream, Biscoe, and in the Joubin Islands. South polar skua reproductive monitoring on Shortcut Island continued throughout February as did the monitoring of the blue-eyed shag colony on Cormorant Island. Kelp gull surveys and chick counts were completed. Growth measurements of giant petrel chicks on Humble Island continued during February and will continue to April.

We are beginning to collect sediment traps with sample processing occurring next month. These traps produce annual presence/absence data of fish and other prey in penguin diets.

As always, we are grateful for ASC support. Special thanks to all the ASC and grantee field volunteers that assisted with Adélie fledgling measurements and activities that required two boats.

C-019-P: PALMER, ANTARCTICA LONG TERM ECOLOGICAL RESEARCH (PAL-LTER): ECOLOGICAL RESPONSE TO "PRESS-PULSE" DISTURBANCES ALONG A RAPIDLY CHANGING WEST ANTARCTIC PENINSULA
Dr. Oscar Schofield, Principal Investigator, Rutgers University, Institute for Earth, Ocean, and Atmospheric Sciences, Department of Marine and Coastal Sciences
Personnel on station for month of January: none

C-045-P (Van Mooy) and B-285-P (Bowman) grantees have continued baseline Station E and pump house sampling for the C-019-P (Schofield) lab. This is detailed in each of their reports.

C-020-P: PALMER, ANTARCTICA LONG TERM ECOLOGICAL RESEARCH (PAL-LTER): ECOLOGICAL RESPONSE TO "PRESS-PULSE" DISTURBANCES ALONG A RAPIDLY CHANGING WEST ANTARCTIC PENINSULA
Dr. Deborah Steinberg, Principle Investigator, Virginia Institute of Marine Science, Department of Biological Oceanography
Personnel currently on station: Maya Thomas

Summer is coming to an end at Palmer Station but despite the worsening weather the C-020-P (Steinberg) lab continues to sample at Station E. This month we were able to successfully conduct our twice-weekly zooplankton tows off of RHIB HADAR while also deploying and recovering three sediment traps with the C-045-P (Van Mooy) lab and conducted two dissolved organic matter (DOM) experiments. Maya Thomas, our labs' representative on Station, has spent her time off the water exploring the data associated with all of this work.

For years, the C-020 (Steinberg) lab has done an extra net tow with the ring net for animal biomass and gut fluorescence. Animal biomass is collected to measure the weight of the animals caught and animal gut fluorescence can give us an estimate of phytoplankton consumption. We prepare our tow for this analysis onboard RHIB HADAR by first splitting the entire tow in half using a Folsom plankton splitter. One half of the tow is saved to be processed back at Station and the other half is processed immediately on the boat through the same methodology. Half of the sample is divided by size as the sample is sorted through a stacked sieve set. Then, each size fraction is collected separately on a mesh filter. The half processed while on RHIB HADAR is for gut fluorescence analysis and must be flash frozen in liquid nitrogen to reduce the amount

that the chlorophyll fades in the zooplankton's guts. The other half of the tow is less time-sensitive and will be sorted and stored in the freezer once back at station.

Figure 10- Maya Thomas sorting the gut fluorescence sample by size onboard Hadar. *Image credit: Hannah James.*

In addition to the regular gut fluorescence/biomass measurements, there has been an increase in Dissolved Organic Matter (DOM) experiments for Maya's Ph.D. research. As stated in a previous science report, "DOM comes from animals in many forms but we will be primarily looking at dissolved carbon, nitrogen, and phosphorous added to the water as animals feed and excrete." So far, there have been five of these experiments total with a variety of animals including two types of krill species, *Euphausia superba* and *Thysanoessa macrura,* and a mixed experiment with various zooplankton including multiple species of copepods, chaetognaths, and other crustacean species.

Figure 11- Incubating animals in the flow-through tank set up in the Palmer Station aquarium room. Animals are stored here for the length of the experiment to keep the temperature relatively consistent throughout. *Image credit: Maya Thomas.*

The flexibility and shifts in the zooplankton community at Station E reflects the shift in the mission of the zooplankton lab at Palmer Station. Previous work done by our lab has shown that throughout the summer season the most common zooplankton species change. For Maya, this has meant changing the focus of her Ph.D. project to different animals as the season has continued. Similarly, we have had a season where personnel and equipment have shifted on station and we have had to become adaptable to all the changes happening around us. Although this has been difficult at times we must acknowledge that this season would not have been as successful

without the continued support of ASC staff, including the boathouse, science support, and the RHIB HADAR volunteer team affectionately known as the "Hadarmy." With only one member of the Steinberg lab on station, zooplankton collection and experimentation would not have been possible without their generous support.

C-024-P: Palmer, Antarctica Long Term Ecological Research (PAL-LTER): Ecological Response to "Press-Pulse" Disturbances Along a Rapidly Changing West Antarctic Peninsula

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

Survey Efforts and Data Collection Summary

February marked the start of the 2023-24 season for the C-024-P (Friedlaender) group, with field team members Ross Nichols (lead) and Helena Dodge based at Palmer station. 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 R/V LAURENCE M. GOULD collect similar data across the LTER oceanographic sampling grid.

The station team conducted daily visual surveys aboard the SOLAS vessel Avior, primarily in the local boating area around Palmer Station. As opportunity permitted, we additionally utilized the regional 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 March 2nd, we have conducted over 69 hours of surveying, during which time we have observed 140 humpback whales (59 non-mother adults, 10 juveniles, 34 mother-calf pairs and 4 of unknown age class). We have collected 70 biopsy samples (29 non-mother adults, 7 juveniles, 20 mothers, and 14 calves). We have 84 individual animal flukes for individual ID and drone-derived morphometrics for 47 humpback whales. We have not deployed any animal-borne tags from station to date, but two tags were deployed by our team on the R/V LAURENCE M. GOULD during the LTER cruise. See summary statistics for sampling in Table 1.

Table 1- 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).

	Adults	Juveniles	Mothers	Calves	Total
Observations	59	10	34	34	140
Photo-IDs	43	6	23	12	84
Biopsies	29	7	20	14	70

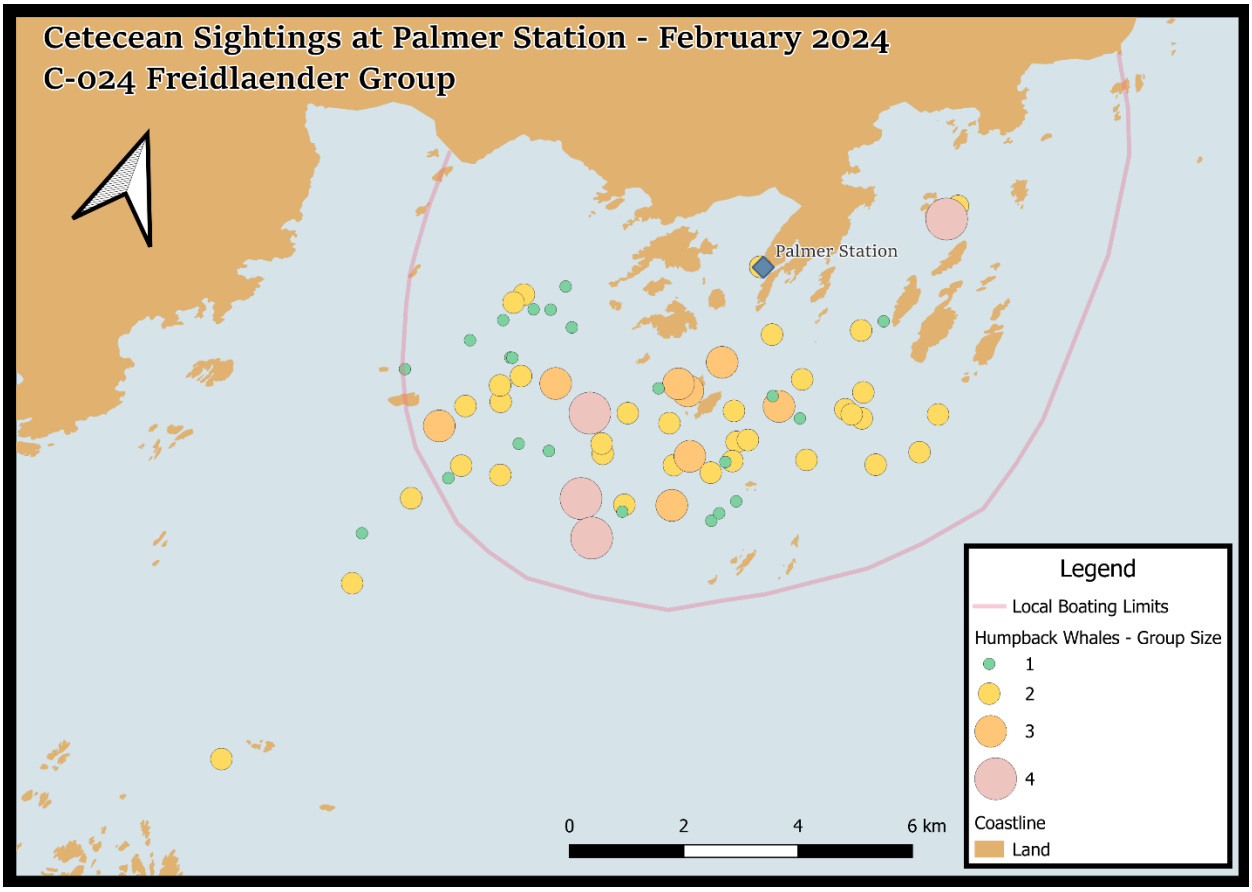

Figure 12- A map of all humpback whale sightings between January 29th and March 2nd by C-024. Color and size indicates group size, with green representing solo individuals, yellow is groups of 2, orange groups of 3, and red is 4+ individuals. *Figure Credit Ross Nichols*

Photo-Identification

Photo-identification is done using the markings, scarring, and coloration on the fluke of the animal (Fig. 11). 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 15 individuals were observed in multiple sightings and the vast majority were re-sighted within 1-2 days. 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 re-sighted, 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 13-A humpback whale fluke photo-ID shot taken during our 2024 surveys, showing clear black and white identifying marks. *Image credit Helena Dodge*

Biopsy Tissue Sampling

The biopsy samples (Fig. 12) 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 14- Biopsy dart with biopsy visible at the time of sample collection on a humpback whale. Collected under permits: NMFS 23095, ACA 2020-016, and IACUC Frie2305dn. *Image credit Ross Nichols*

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. 13). 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.

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 February our team conducted 34 successful UAS flights near Palmer Station and within the Palmer Boating Area: 4 test flights from station and 30 flights for whale photogrammetry and behavioral observation. The whale photogrammetry flights have taken place throughout the local and extended boating area.

Figure 15- A screenshot from a video collected by a drone that will be used for photogrammetry and measurement of an adult humpback whale. Collected under permits: NMFS 23095, ACA 2020-016, and IACUC Frie2305dn. *Image credit Ross Nichols.*

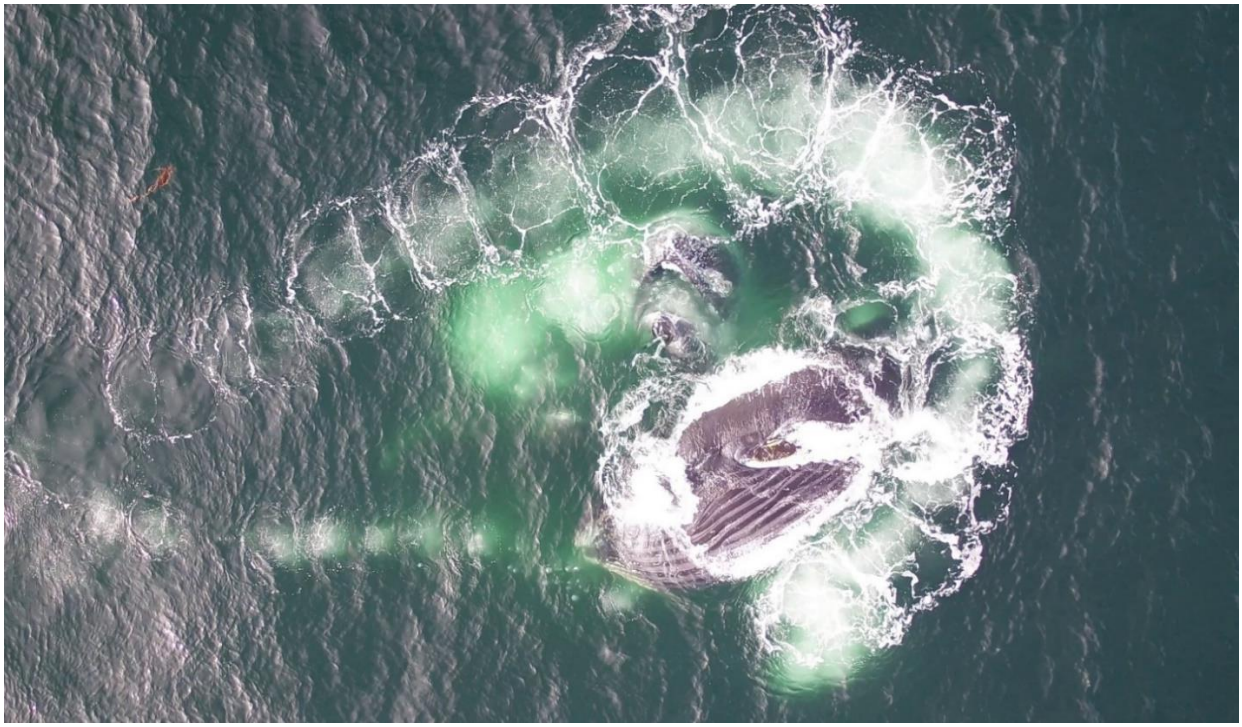

Figure 16- Two adult humpback whales perform a bubble net and are seen performing a feeding lunge at the surface of the water Collected under permits: NMFS 23095, ACA 2020-016, and IACUC Frie2305dn. *Image credit Ross Nichols.*

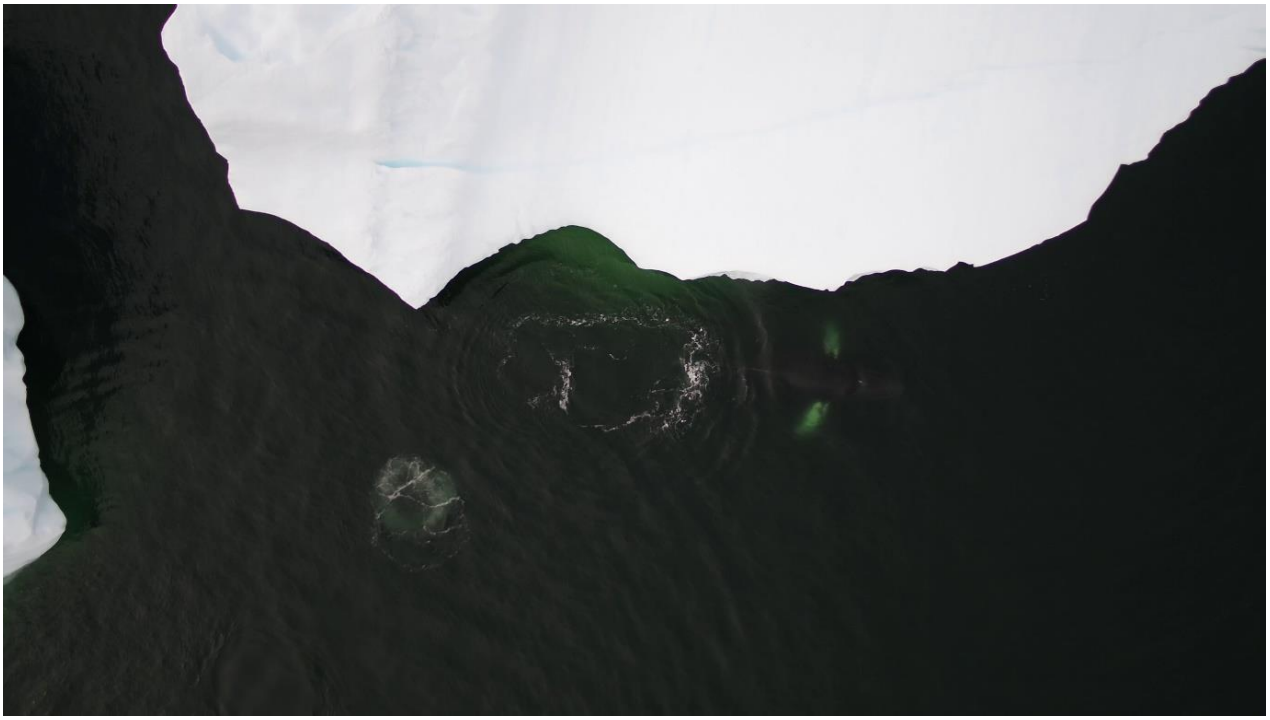

Figure 17- An adult humpback whale swims close to an iceberg and can be seen underwater. This image was captured as a screenshot taken from an aerial drone video. Collected under permits: NMFS 23095, ACA 2020-016, and IACUC Frie2305dn. *Image credit Ross Nichols.*

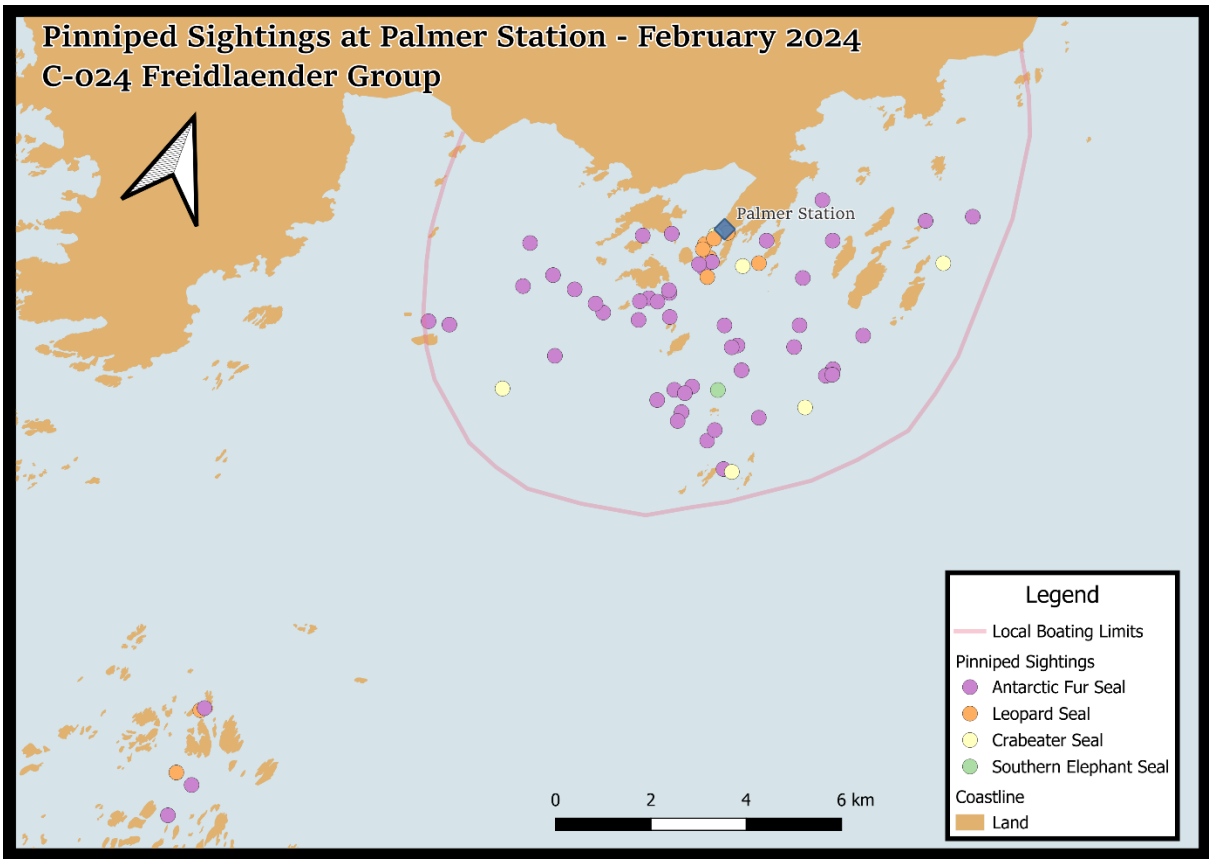

Figure 18- Sightings of Pinniped Species during our 2024 surveys. *Figure Credit Ross Nichols*

C-045-P: Palmer, Antarctica Long Term Ecological Research (PAL-LTER): Ecological Response to "Press-Pulse" Disturbances Along a Rapidly Changing West Antarctic Peninsula

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

Personnel on station: Shavonna Bent

February was another busy month of science for C-045-P (Van Mooy). With R/V HADAR able to be left on the mooring after the departure of the iceberg that had been resting in Hero Inlet for over a month, we were able to sample from Station E seven times, six of which were full CTD profiles off of R/V HADAR (rather than the reduced profile of five depths sampled via zodiac). Sampling continued for the standard parameters collected by C-045-P (Van Mooy), including lipids, carbohydrates, particulate organic carbon (POC), flow cytometry, nutrients, and $\delta^{18}O$. The Accuri C6 flow cytometer was experiencing issues with flow rate, so for approximately half the month samples were fixed for later analysis. This issue is under current troubleshooting, with support from ASC on station. Further, we were able to deploy and recover two more sediment traps, from which we sampled POC, lipids, and carbohydrates, and C-020-P (Steinberg) obtained gels for imaging analysis from both traps.

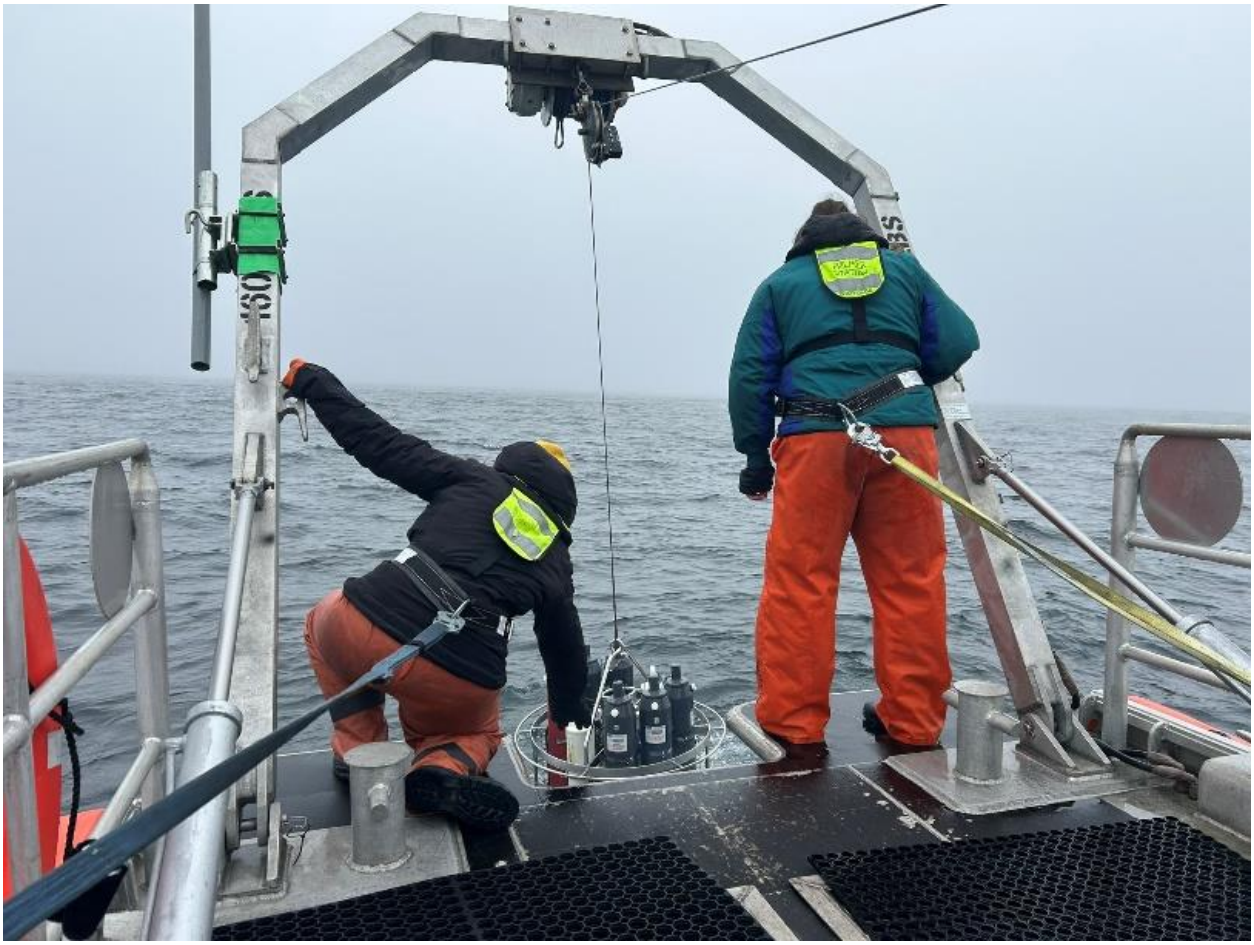

Figure 19- C-045-P (Van Mooy) grantee Shavonna Bent (left) and B-285-P (Bowman) grantee Beth Connors (right) deploy the CTD off R/V HADAR at Station E. *Image credit: Amy Varga*

The reduced sampling efforts for C-019-P (Schofield) were fully incorporated into our sampling efforts for the month of February, and for each sample collected by C-045-P (Van Mooy) we further filtered or fixed cells for high performance liquid chromatography (HPLC) analysis of pigments, chlorophyll α, and the imaging flow cytobot (IFCB). The continuation of the time-series for these parameters has only been made possible via close coordination of ASC volunteers to help with R/V HADAR operations, and efforts of the B-285-P (Bowman) grantee Beth Connors.

As the daylight began to fade in the middle of February, grantee Shavonna Bent was able to conduct a third diel experiment, collecting water from the Pump House every six hours. However, due to the increased workload caused by reduced personnel, this effort was collapsed into three days rather than five, representing the minimum required timepoints to obtain diel cycles. This experimental timeframe was critical to understand how phytoplankton from the end of the bloom, adapted to high light levels, were responding to the rapidly decreasing photoperiod.

In conjunction with the C-013-P (Cimino) birding group the end of diet sampling was successfully wrapped up in February. Nearly 100 diets were collected and homogenized during this field season. Shavonna was also able to join the birders in the field and obtained ~25 fecal samples from islands where diets are commonly collected.

PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT
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Marissa Goerke

Figure 20- A berg with an arch near Hermit Island, February 20, 2024. *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.

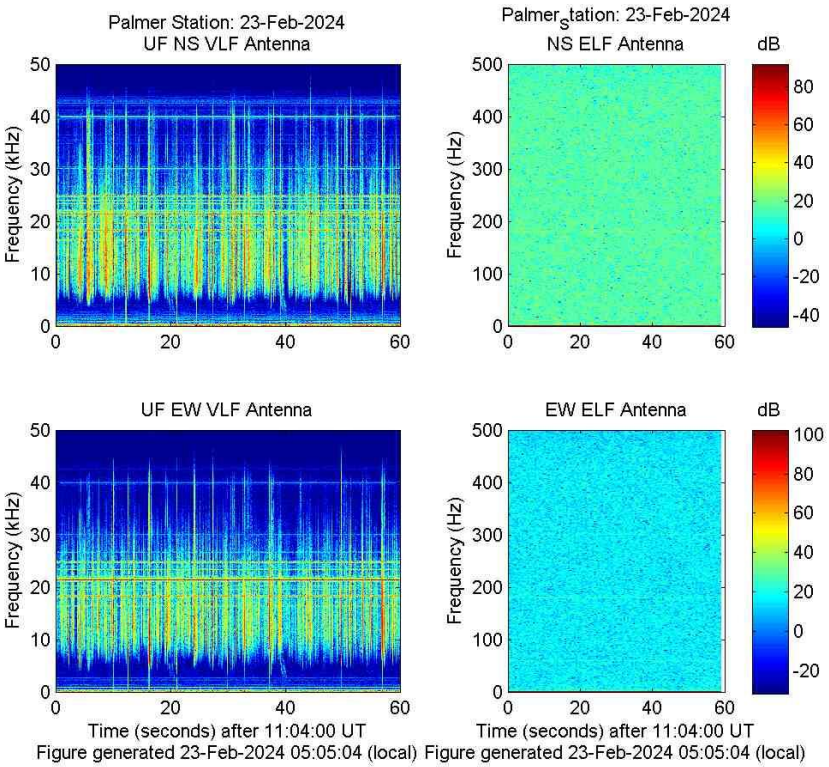

Figure 21. Real-Time broadband VLF and ELF spectrogram from Palmer Station, Antarctica.

The GPS receiver did not weather the October outage and remains unlocked. A replacement GPS receiver is in the shipping stream. Both systems will continue to run without the GPS lock through April. The Research Associate reviewed the spectrograms, and 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. The new Raspberry Pi system was installed January 2024. The system operated normally this month. More information can be found at: http://magnetometers.bc.edu/index.php/palmer.

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-P) 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.

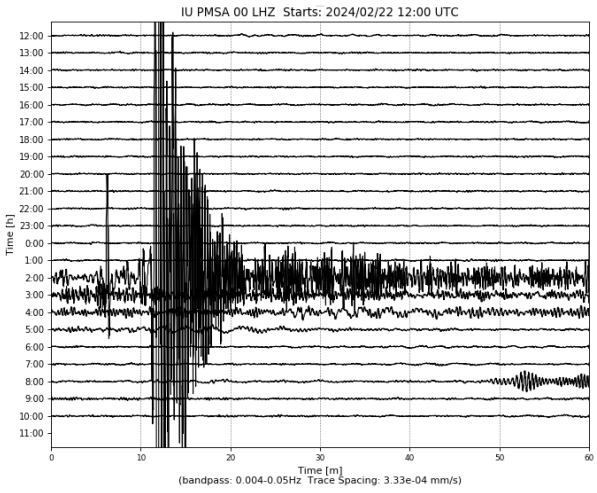

Figure 22. The February 22, 2024 6.3 earthquake near the southern East Pacific Rise, as recorded from the Palmer seismic station.

The system suffered several multiday network related outages throughout February. The underlying network problem has not yet been resolved. 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.

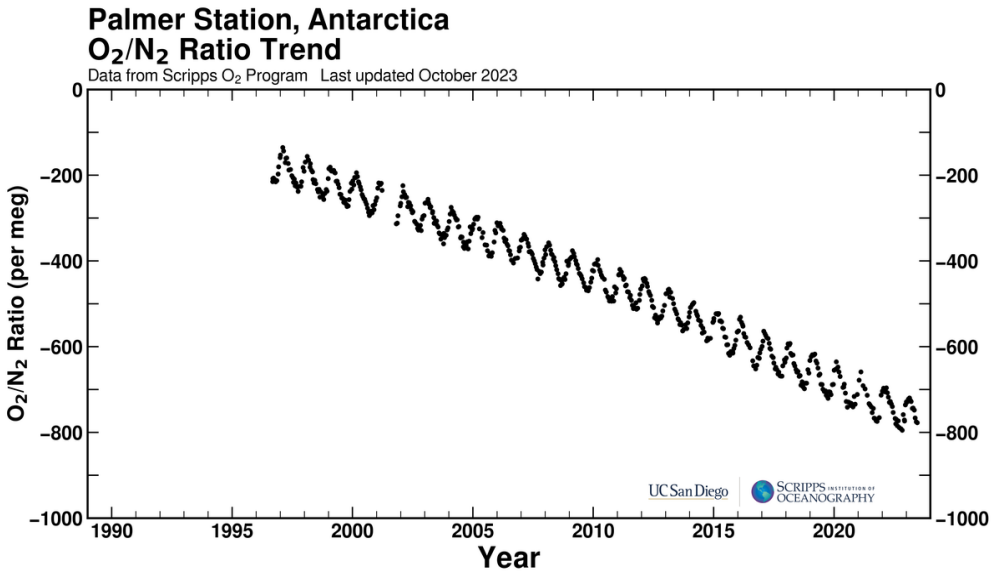

Figure 23. Historical plot of O_2/N_2 ratio per meg and CO_2 ppm updated October 2023.

Air samples were collected on February 1 and February 17. 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 are shipped to the 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 Laboratory; 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 February 1, February 6, February 12, February 19, and February 27 during favorable wind conditions. More information and data for the Carbon Cycle group can be found at: https://gml.noaa.gov/ccgg/.

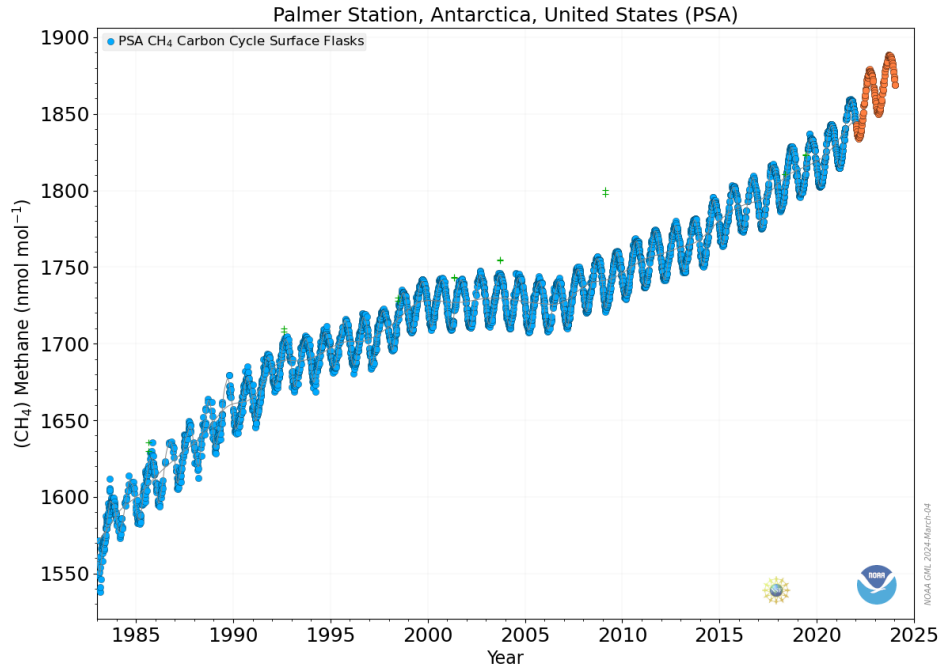

Figure 24. Methane (CH_4) levels at Palmer Station dating back to 1984. Orange dots are preliminary data.

HATS samples were collected on February 2 and February 21 during favorable wind conditions. More information and data for the Halocarbons and other Atmospheric Trace Species group can be found at: https://gml.noaa.gov/hats/

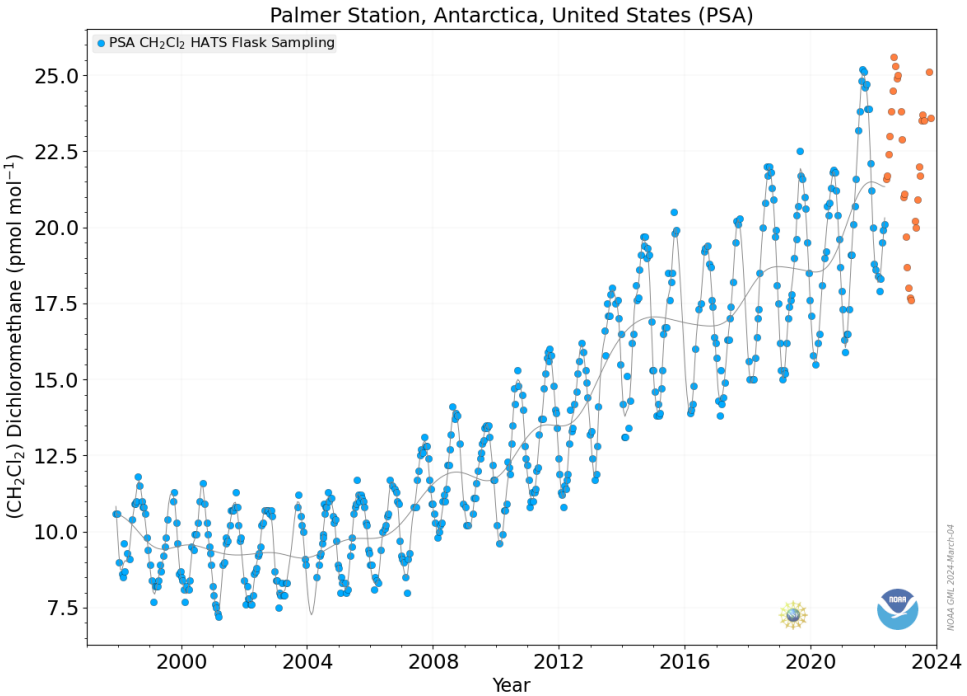

Figure 25- Dichloromethane (CH_2CL_2) levels at Palmer Station dating back to 1998, one of the Halocarbon and Trace Gases measured at Palmer Station. Orange dots are preliminary data.

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 Laboratory; 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.

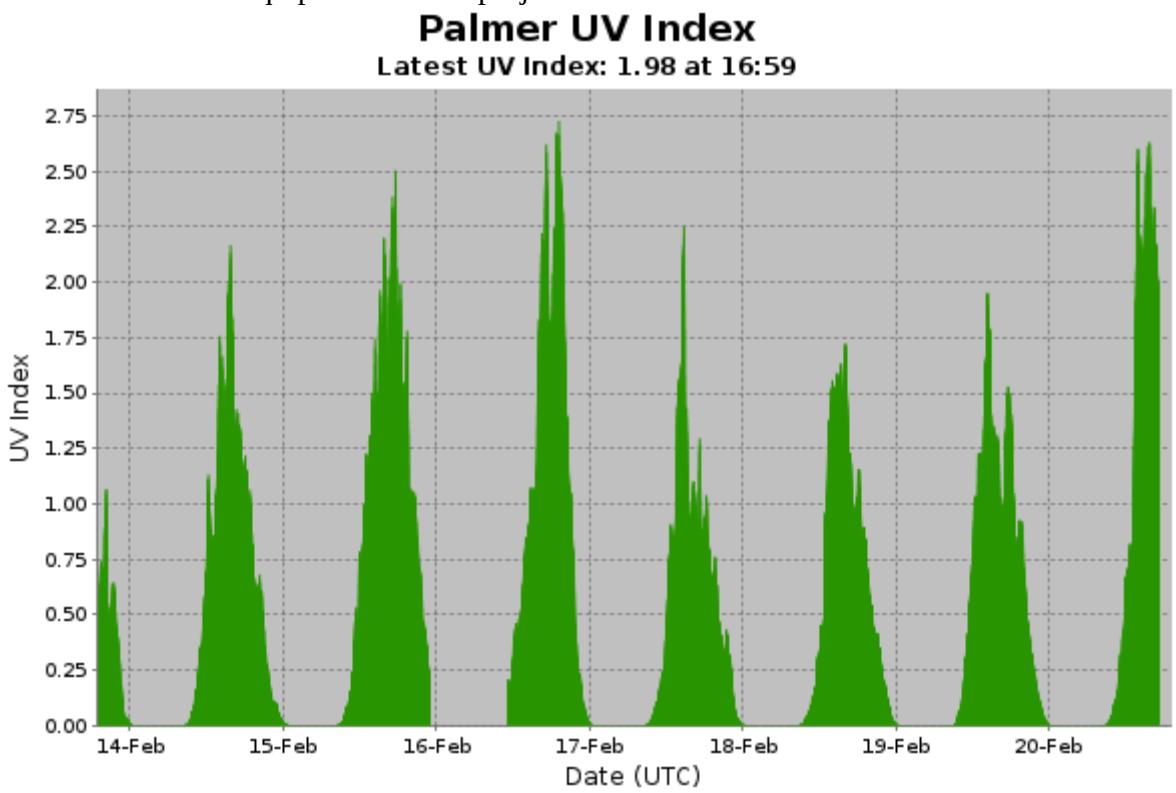

Figure 26. UV index generated from the GUV-511 radiometer in real time.

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 an SUV-100 was performed on February 12 and February 26 without issues. 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.

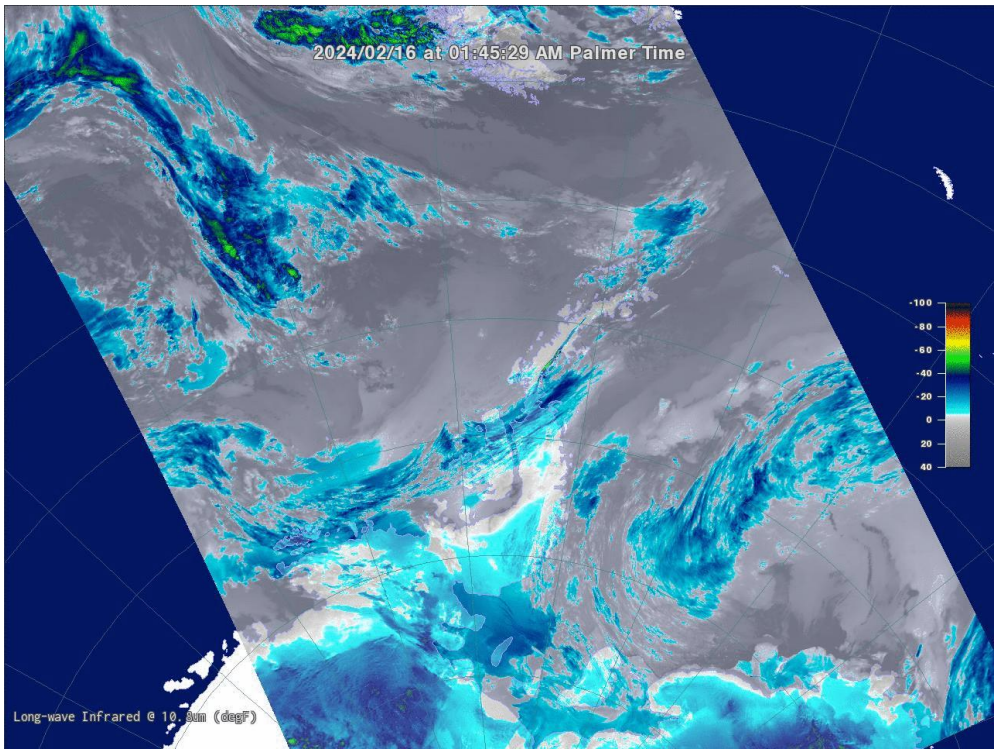

Figure 27. NOAA-18 February 16 satellite pass

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

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's splitter failed in December 2023 and the system is operating on only one GPS receiver instead of the normal two. The glacier backyard terminus, profile and Point 8 terminus were surveyed throughout February.

For more information, visit: 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 U.S.A. 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. The system operated normally this month.

Additional details about the treaty and monitoring stations can be found on the CTBTO website, 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 depth 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. The system operated normally this month.

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/.

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 to the University of Wisconsin on the first day of each month for archiving and further distribution. The system operated normally this month.

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

Palmer Monthly Met summary for February, 2024

Temperature
Average: 1.8°C / 35.2°F
Maximum: 7.8°C / 46.04°F on 27 Feb 19:04
Minimum: -1.1°C / 30.02°F on 4 Feb 06:44
Air Pressure
Average: 982.8 mb
Maximum: 1000.9 mb on 26 Feb 05:32
Minimum: 949.6 mb on 5 Feb 14:54
Wind

Average: 10 knots / 11.5 mph
Peak (5 Sec Gust): 48 knots / 55 mph on 13 Feb 06:55 from NE (034 deg)
Prevailing Direction for Month: NNW
Surface
Total Rainfall: 79 mm / 3.11 in
Total Snowfall: 3 cm / 1.2 in
Greatest Depth at Snow Stake: 12.2 cm / 4.8 in
WMO Sea Ice Observation: More than 20 bergs, bergy bits, growlers, brash ice
Average Sea Surface Temperature: 0.71 °C / 33.3 °F

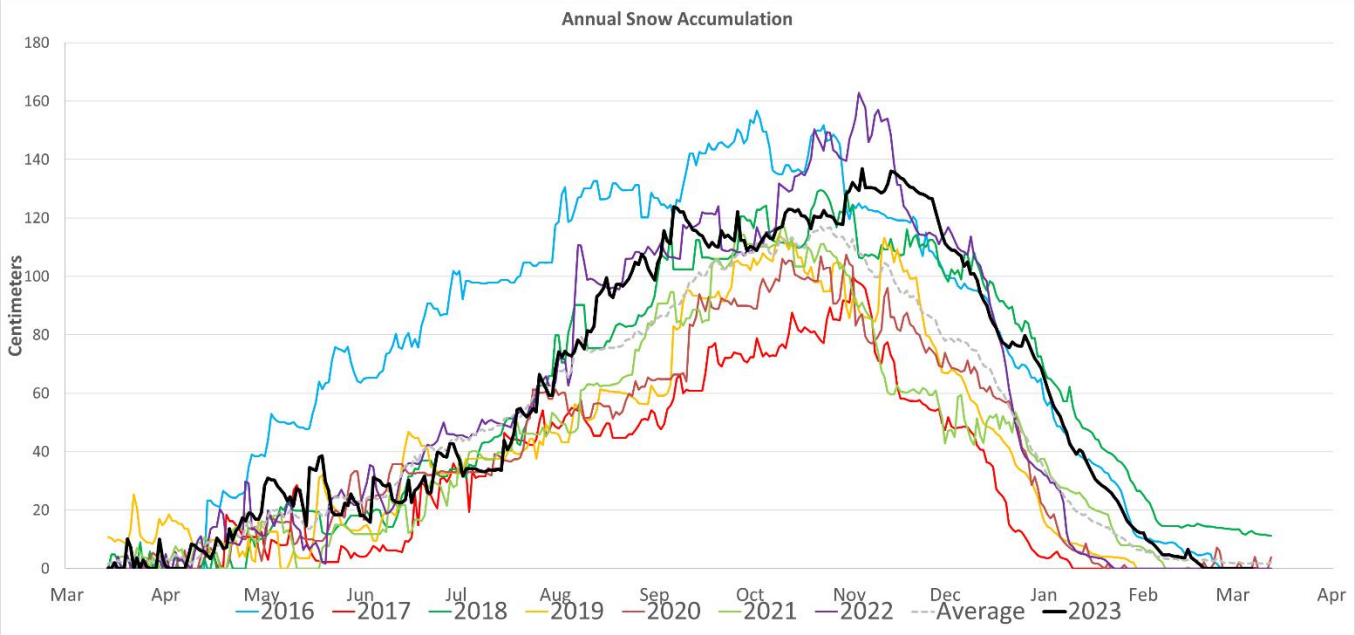

Figure 29: Snow Accumulation and Melt for 2023: The snow stuck around almost a month later this year as compared to the 2022 snow year. *Figure credit Marissa Goerke*