PALMER STATION MONTHLY SCIENCE REPORT

November 2023

Icebergs have frequented the skyline of Palmer Station throughout the start of the summer. Some have floated in to Hero Inlet and Arthur Harbor, dwarfing over Palmer Station structures. Even larger bergs have passed through the local boating area. *Image credit: Alex Mendelson*

NEWS FROM THE LAB
Hannah James, Summer Laboratory Supervisor

The first week of November was the true start of summer science for the 2023-2024 Palmer Station summer field season. The ARSV LAURENCE M. GOULD tied up to the Palmer Pier on November 4th. Five groups arrived, settled into their lab spaces, and jumped right into field work. The C-013-P (Cimino), C-020-P (Steinberg), and C-045-P (Van Mooy) grantees are back to join C-019-P (Schofield) for the 33rd year of Palmer Station LTER. B-285-P (Bowman) grantee Beth Connors returned for her second season working under the Bowman Lab, and Jay Helmericks and Matthew VonLintig from T-396-P (Blom) arrived for a month-long field season to install a temporary infrasound array.

After a blustery first week, the weather remained remarkably calm with very little swell in the area, though large icebergs continue to dominate the skyline as one looks out to the horizon in any direction. RHIB Hadar's mooring was put in place in Hero Inlet and the Floating Dock was installed November 20th by FMC. We were shoveling the boardwalks pretty consistently the first few weeks of November, but now the snow melt season officially started. More and more wildlife returned to the surrounding Palmer area throughout the month, as we are frequently seeing Gentoo Penguins haul out around station. Gentoos have remained at Point 8, making their way through the numerous elephant along the shoreline. Skuas are slowly returning to station, and the birding team even spotted an early fur seal in the area.

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: Beth Connors

B-285-P (Bowman) has had an excellent start to the 2023-2024 season. Bowman lab PhD student Beth Connors is deploying solo for our project this season which is the second and final deployment for this project. We are examining bacterial and viral dynamics for the season, with an emphasis on top-down (grazing) control on bacteria and the impact of grazing on carbon flow in the marine environment. One of the most important tools for this work is flow cytometry, where a laser is used to count stained cells from a marine sample. The below graph is a recently analyzed flow cytometry sample from our deployment last year (28 December 2022), where the different colors are different cell populations in a 14µl sample of seawater from 10m at Station E, where the majority of CTD casts occur. Cluster 4 (green) are the bacterial cells with higher nucleic acid (higher green fluorescence from a DNA stain called Sybr Green that we added to the seawater). This month, after arriving at Palmer and setting up our lab space, Connors spent a lot of time verifying our flow cytometer was working correctly, as it is an incredibly important instrument for our experiments.

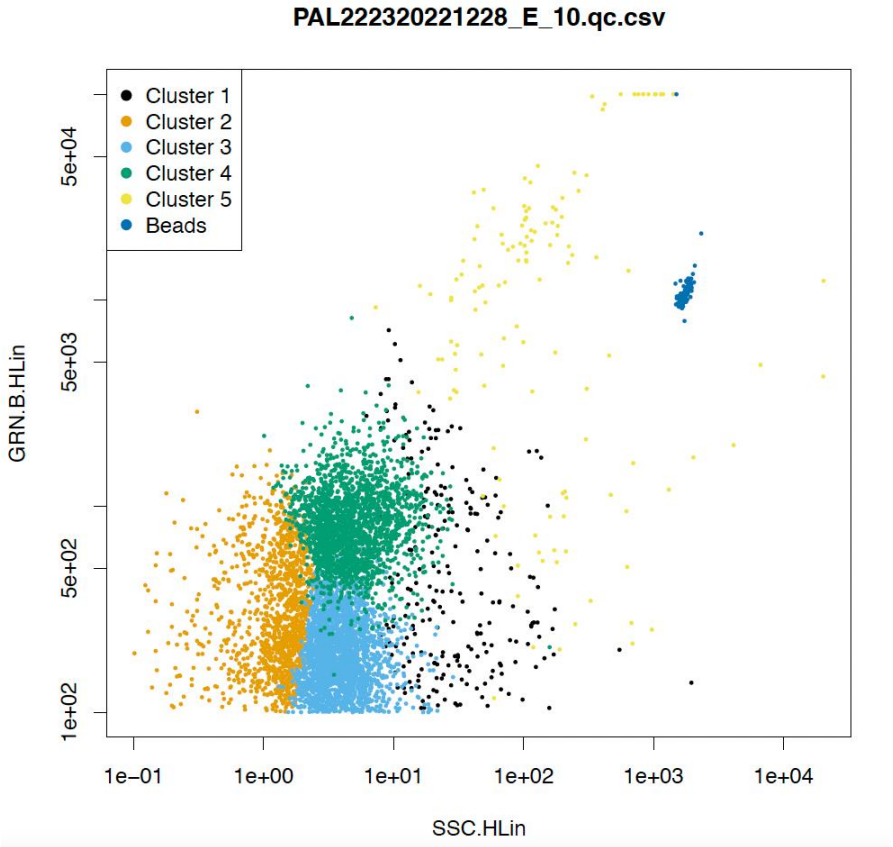

Figure 1 B-285-P (Bowman) flow cytometry output - different colors are different populations. *Figure credit Beth Connors.*

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: Helena Dodge and Darren Roberts

C-013-P (Cimino) personnel arrived at Palmer Station on November 4th. Weather in November was varied but we were able to get out on the water for 18 days of the 27 days we were on station.

Field work this month began with breeding chronology studies on a subset of Adélie nests on Torgersen and Humble Islands. Population assessment of Adélie and Gentoo populations began at Torgersen, Humble, Cormorant, Christine, Biscoe, and Point 8. A portion of Adélie penguin nests were sampled at the 1-egg stage to obtain adult body condition and egg morphometric data. Due to our reduced team size, we used volunteers from station to aid in this measurement. Their help was necessary and appreciated. Timing of a peak egg census was also determined and completed for Adélies in the local group. Peak egg is a measurement of the colony size at its largest for the season. Adélie, Gentoo, and Chinstrap penguin peak egg census will be completed at Biscoe Point and Dream Island as soon as conditions allow.

Figure 2- An Adélie Penguin colony at Torgersen Island. *Image credit: Darren Roberts*

Figure 3- Adélie Penguins at Torgersen Island. *Image credit: Darren Roberts*

FMC aided with the construction of a camera mount for a game camera. We were able to deploy the camera at Biscoe Point. This camera will help to better understand Gentoo penguin phenology at Biscoe.

Brown Skuas have arrived and we began their mark-recapture and breeding chronology studies, including leg band re-sights and monitoring nests in the local area. We also began population assessment and breeding phenology monitoring at the Blue-Eyed Shag colonies on Cormorant Island this month.

South Polar Skua surveys were completed at Shortcut Island to record arrival dates of banded birds. Additionally we completed our annual Thanksgiving Giant Petrel survey at Shortcut.

Giant petrels have begun laying in the area, and we initiated our mark-recapture and breeding chronology studies on this species. We have focused our efforts at Humble, Elephant Rocks, Shortcut, and Litchfield Islands so far. Additionally, we began our effort to recover over winter tags from Giant petrels at Elephant Rocks and Litchfield in November. Deployment of GPS tags began on Giant petrels in November and will continue for the majority of the summer.

Figure 4- A GLS (location) tag recovered from a Giant Petrel at Elephant Rocks. *Image credit: Darren Roberts*

Marine mammal censuses of seals and whales began this month. Pinniped sightings this month included Weddell seals, Leopard seals, Antarctic fur seals, and Southern Elephant seals. We observed evidence of Elephant seal pupping in the local group of islands.

Due to reduced science presence on station, our group is helping with the whale research conducted by C-024-P (Friedlaender). In November we were able to recover, process, and redeploy an acoustic mooring from Station H. Moving into December we will recover the second mooring located in the Wauwerman Islands, and as more whales show up we will begin biopsy sampling work for the C-024-P (Friedlaender) team.

We would like to thank all of the personnel on station for helping us get the season moving. We would especially like to thank the Palmer Lab Manager, Hannah James for her exceptional logistic support. Kody Leonard, and Jeff Keller were a major asset during the one egg measurement. Lance Roth has been extremely helpful in his assistance with the recovery and deployment of the acoustic mooring for C-024-P (Friendlaender).

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 currently on station: Sneha Sivaram

With the arrival of new science groups on station, collaboration and team work have been crucial in getting sampling for the Long-Term Ecological Research (LTER) started. November was a productive month as science is fully underway for the Schofield Lab.

Three new instruments arrived this month: the Imaging Flow CytoBot (IFCB), the Quantative Filter Technique Integrating Cavity Absorption Meter (QFT-ICAM), and the Compact Propulsion Optical Profiler (C-PrOPS). These instruments now complete the Schofield lab for the 2023-24 summer season. The IFCB will be used to monitor phytoplankton community composition by taking images of each particle that passes through the flow through system. The QFT-ICAM is used to take measurements of particulate light absorption to better understand

light absorption in the water column. The C-PrOPS is a sensor which measures the amount of light available for photosynthesis, or Photosynthetically Active Radiation (PAR), in the water column. Other instrumentation in the lab includes the FIRe fluorometer to measure photosynthesis as well as filtration rigs for DNA, high performance liquid chromatography (HPLC) and the main photosynthetic pigment chlorophyll a.

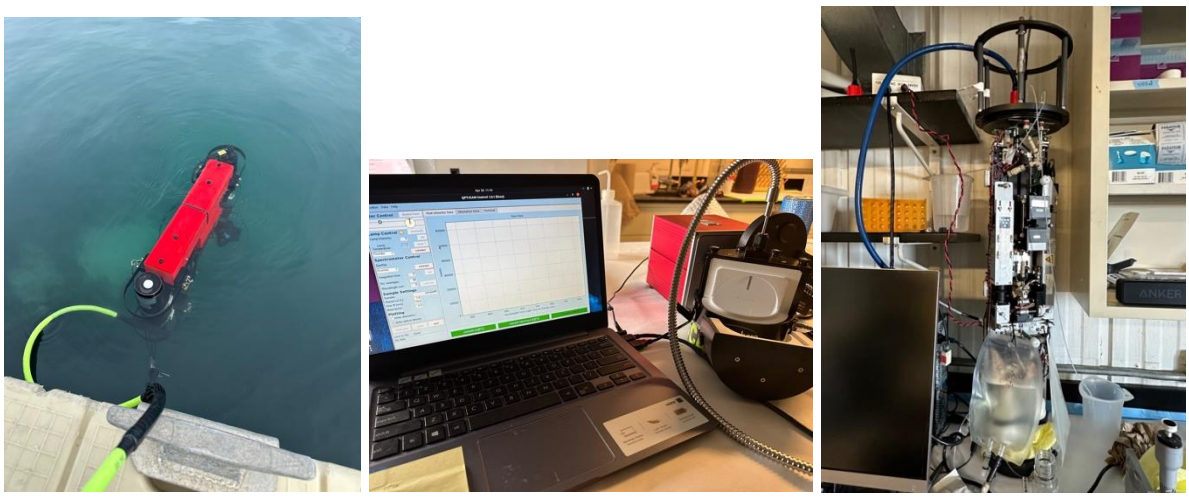

Figure 5- New instrumentation in the Schofield Lab. The C-PrOPS in the water (left), the QFT-ICAM (middle) and the IFCB (right) set up in the lab. *Image credit: Sneha Sivaram*

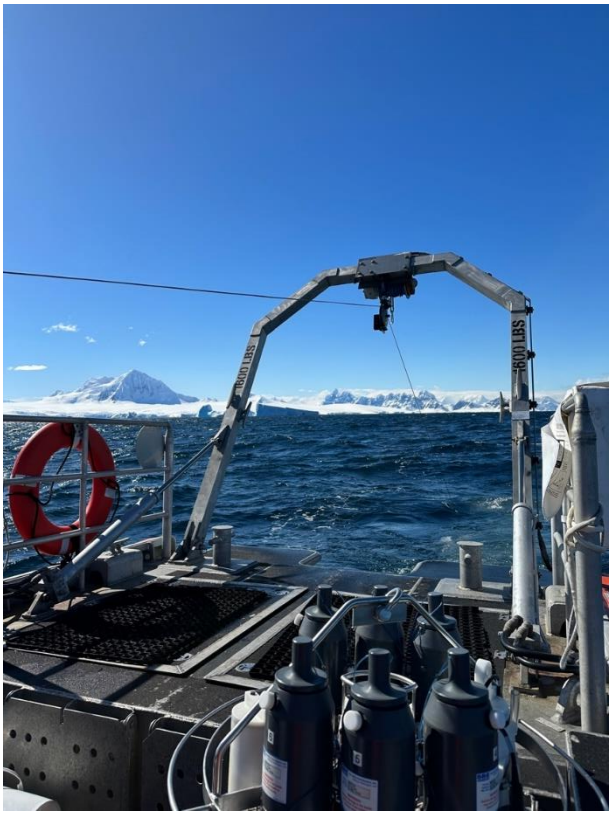

Figure 6- Mountain views on a clear day while sampling at Station E. *Image credit- Sneha Sivaram*

Water from the seawater intake in the pumphouse at Palmer Station is processed daily and also biweekly to monitor the phytoplankton directly around the station. Daily sampling includes IFCB and fluorometry measurements. Biweekly sampling adds filtration and the QFT-ICAM measurements. Biweekly sampling for the LTER involves water collection at 7 depths of the upper water column (0m, 5m, 10m, 20m, 35m, 50m, and 65m) using the CTD rosette at the biological hotspot, Station E. Located at the edge of the Palmer Deep Canyon, Station E is accessible using the small research vessel, RHIB HADAR. The collaborative acoustic transects have also begun this month. There are two transects: one over the Palmer Deep Canyon (Adélie Transect) and the other in Biscoe Bay (Gentoo Transect). Both of these areas are notable foraging areas for Gentoo and Adélie Penguins. These transects look to understand the spatial distribution of krill and predators in the Palmer region as it corresponds with seasonal change using acoustic data from the EK80 and visual predator surveys. CTD casts

are also done throughout the transect to collect information about the water column.

The Schofield lab looks forward to a productive and busy December as the weather conditions continue to improve.

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: Maya Thomas

The zooplankton ecology lab from the Virginia Institute of Marine Science, William & Mary, led by Dr. Deborah Steinberg, has returned to Palmer Station this November for another exciting season of science. This marks our 6th season studying the coastal zooplankton community from Palmer. Ph.D. candidate Maya Thomas is the lead on Station this year and will be conducting pelagic net tows aboard RHIB HADAR at Station E. We are deploying 1-m² frame metro nets and 1-m ring nets to a depth of approximately 50 m to collect and study zooplankton, the organisms living in the near-surface layer of the water column that cannot swim against a current.

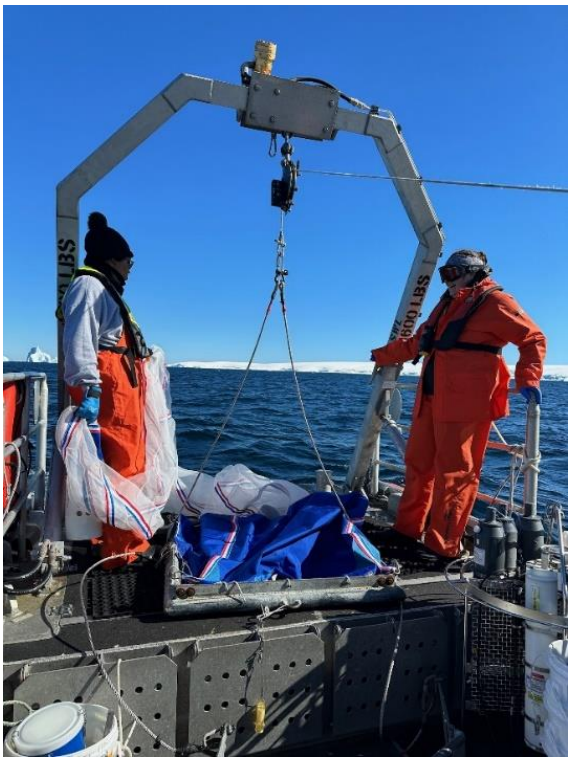

Figure 7- Figure 7- Maya Thomas (left) and B-285-P (Bowman) grantee, Beth Connors (right), preparing to deploy the 1-m² metro net from Hadar. *Image credit Sneha Sivaram.*

In previous seasons, the zooplankton we commonly captured 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 throughout the austral summer season (November through April). Additionally, we are 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).

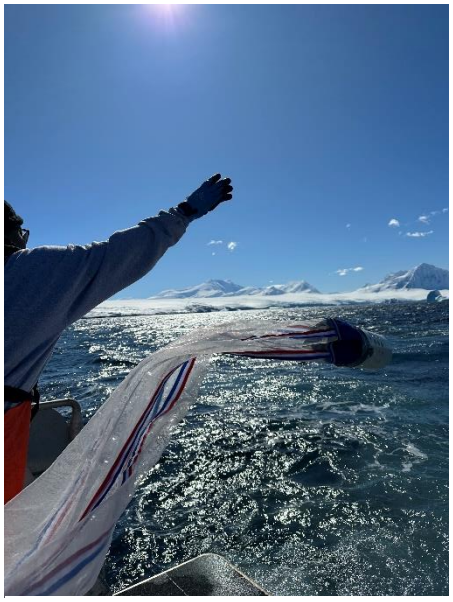

Figure 8 - Maya Thomas deploying the cod end of the 1-m² frame metro net off the stern of Hadar. *Image- Sneha Sivaram*

We plan to deploy net tows twice weekly at Station E and recently completed our first week of tows. With the gorgeous weather we've gotten recently we've been able to successfully deploy both the metro and ring net and bring back animals. Each day we were able to collect a variety of adult and juvenile *E. superba*, copepods, and even some gelatinous ctenophores!

Now that we are getting into the groove of net tows, we would like to begin to do dissolved organic matter (DOM) experiments. 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. These experiments will be a part of Maya's Ph.D. project to quantify the rate and amount of DOM production from copepods at current water temperatures and water temperatures increased to projected future levels with global climate change. For these experiments, Maya will be collecting extra copepods and keeping them alive in Palmer Station's environmental rooms.

As December approaches the C-020-P (Steinberg) team is excited to see how the zooplankton community around Palmer Station changes as we enter the austral summer!

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: Shavonna Bent

The Van Mooy group arrived to Palmer Station at the beginning of November and jumped directly into sampling with set-up support from the other water sampling science groups on station: C-019-P (Schofield), C-020-P (Steinberg), and B-285-P (Bowman). The first experiment conducted involved sampling from the pumphouse every six hours over the course of five days to track the potential for diel cycles. Samples were taken at 0700, 1300, 1900, and 0100 local time. Previous studies from the Van Mooy lab have shown phytoplankton in subtropical environments drastically change their lipid stores over the course of a 24-hour period. Graduate student Shavonna Bent aims to understand if these cycles are also present in the polar environment, where the photoperiod is so different. She will repeat these five-day sampling efforts over the course of the austral summer, to better understand how these adaptations might change as daylight increases to being nearly constant at the solstice, and then again as darkness returns at the end of the season.

In addition to sampling for diel experiments, and weekly pumphouse samples in concert with the C-019-P (Schofield) group, we have begun sampling at Station E after some delays due to weather and engine troubles with RHIB HADAR. During each event we collect samples for the

following analyses: particulate organic carbon (POC), lipids, carbohydrates, nutrients, $\delta^{18}O$ isotopes, and nutrients (including nitrate, phosphate, and silicate). During Station E days we obtain samples from the surface, 5, 10, 20, 35, 50, and 65 m.

This month we also conducted testing for the newly added particle interceptor traps (PITs), which will be used to collect sediment raining out of the euphotic zone near Station E. The buoyancy test had positive results, and we obtained ballast for the moorings thanks to the efforts of the pipe-fitter on station for the Waste Heat Loop project (many thanks to Robert Crowetz!). We delayed deployments of these PITs due to the presence of large icebergs in the local boating area, including several that have moved over Station E. After discussion with the research technician on station (Marissa Goerke), we have determined it is likely that these will be present throughout most of the season, as there is a large ice field moving north along the peninsula that extends for hundreds of kilometers. Deployments of sediment traps will therefore begin in earnest at the beginning of December.

We would like to thank all of the ASC staff who have helped get our season underway successfully, and the other scientists on station! With reduced numbers this season, collaboration is key, and we have started the year with this mindset at the forefront.

T-396-P: Test Survey Of A CTBT Class Infrasound Array at Palmer Station

Mr. Lucas Blom, Operations Manager, Wilson Alaska Technical Center, University of Alaska, Fairbanks

Personnel on station: Jay Helmericks, Matt VonLintig

The Wilson Alaska Technical Center arrived at Palmer Station 4 November, 2023. The team's goal was to identify good locations for infrasound sensors and to deploy a temporary array of sensors. The ultimate goal is to install a permanent infrasound monitoring station in support of the US contribution to the Comprehensive Nuclear-Test Ban Treaty (CTBT) at these sites in the future. The team identified three sites on Amsler Island, one site on Dietrich Island, two sites on Anvers in the Palmer Station backyard, and two sites on Bonaparte Point for a total of 8 locations – a typical number for an infrasound array in the International Monitoring System (IMS). The array of sensors are able to detect local icefall events and other nearby pressure disturbances in the atmosphere as well as signals from further away. The equipment for the temporary study will

be removed when the team leaves Palmer Station headed back to Fairbanks, AK in early December.

Figure 9- Jay Helmericks, lead engineer at WATC, carries a tripod and other gear to one of the infrasound survey locations on Amsler Island. This particular site was disturbed by an elephant seal within 3 days of deploying the equipment, and again a week later. Palmer Station is seen in the background of the photo. *Image Credit: Matt VonLintig*.

PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT
Novemner 2023
Marissa Goerke

Ice bergs on the way to service the Wauwermans AWS, November 22, 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.

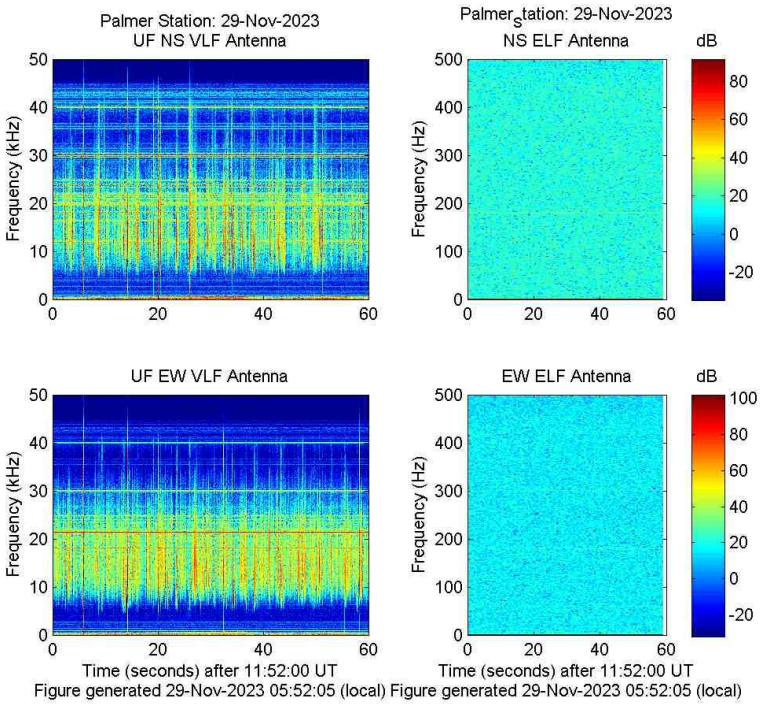

Figure 10. *Real-Time broadband VLF and ELF Spectrogram from Palmer Station, Antarctica.*

Both the Extremely Low Frequency and Very Low Frequency systems suffered a 4 day outage during the power outage in early October. The GPS receiver did not weather this outage and remains unlocked. A replacement GPS receiver is being prepared for shipment. Both systems continue to run without the GPS lock through November. 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 March 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. A new Raspberry Pi is on its way down to replace the existing BeagleBone computer. Once installed, the Pi will permit the system to connect to the USAP network. 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.

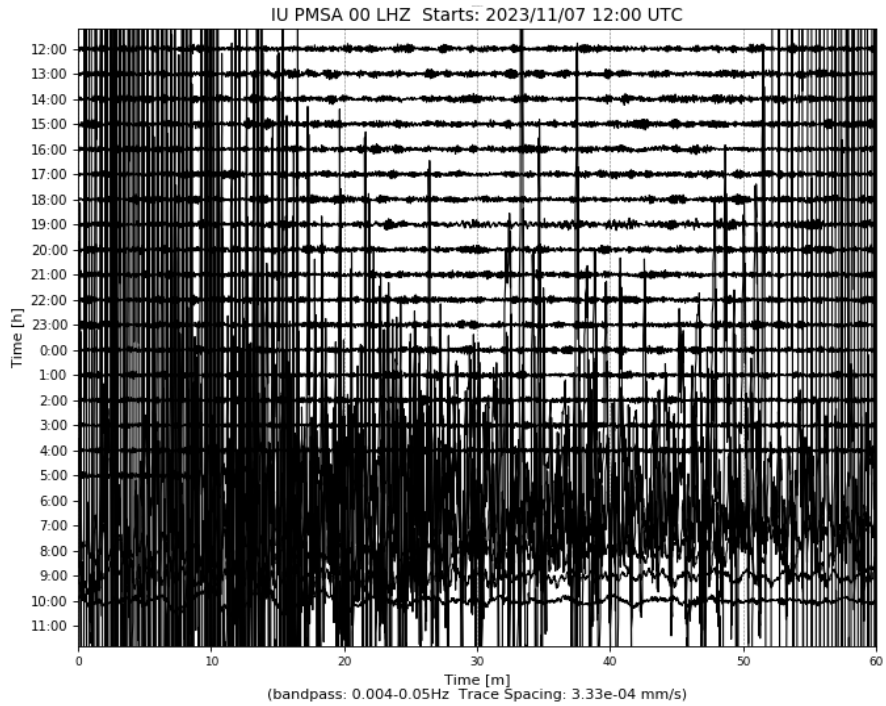

Figure 11. *The November 8, 2023 6.5 earthquake in the Banda Sea, as recorded from the Palmer seismic station.*

The system suffered several multiday network related outages throughout November. The underlying 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.

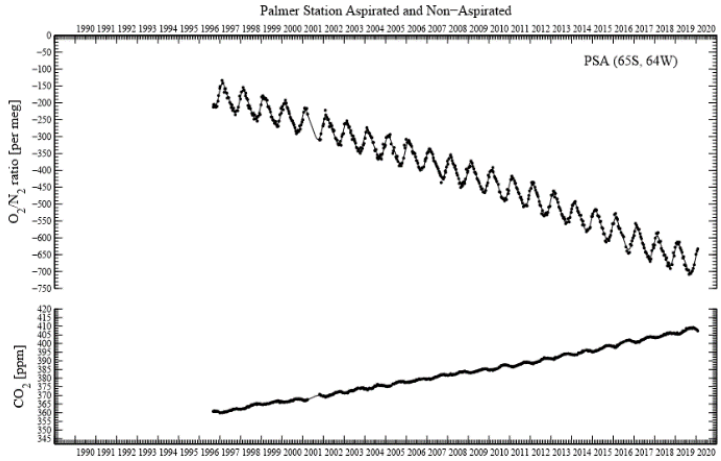

Figure 12. *Historical plot of* $\boldsymbol{O_2/N_2}$ *ratio per meg and* $\boldsymbol{CO_2}$ *ppm updated on July 29, 2020.*

Air samples were collected on November 1 and November 13. 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 November 7, November 14, November 20, and November 27 during favorable wind conditions. More information and data for the Carbon Cycle group can be found at: https://gml.noaa.gov/ccgg/.

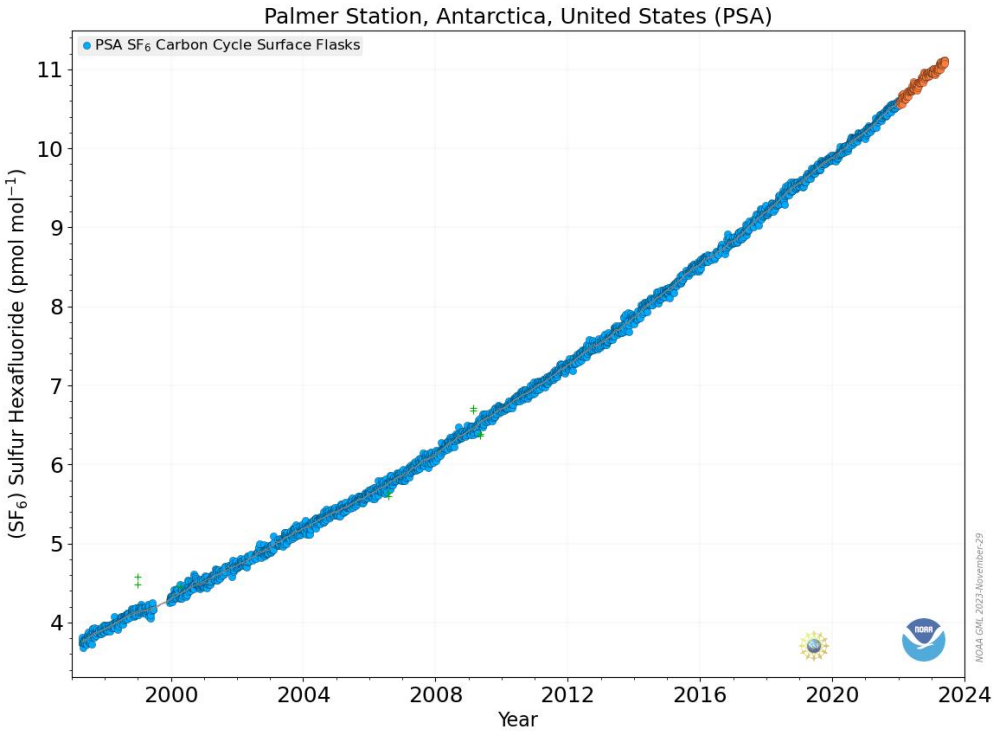

Figure 13. *Sulfur Hexafluoride (SF_6) levels at Palmer Station dating back to 1997. Orange dots are preliminary data.*

HATS samples were collected on November 14, and November 29 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/

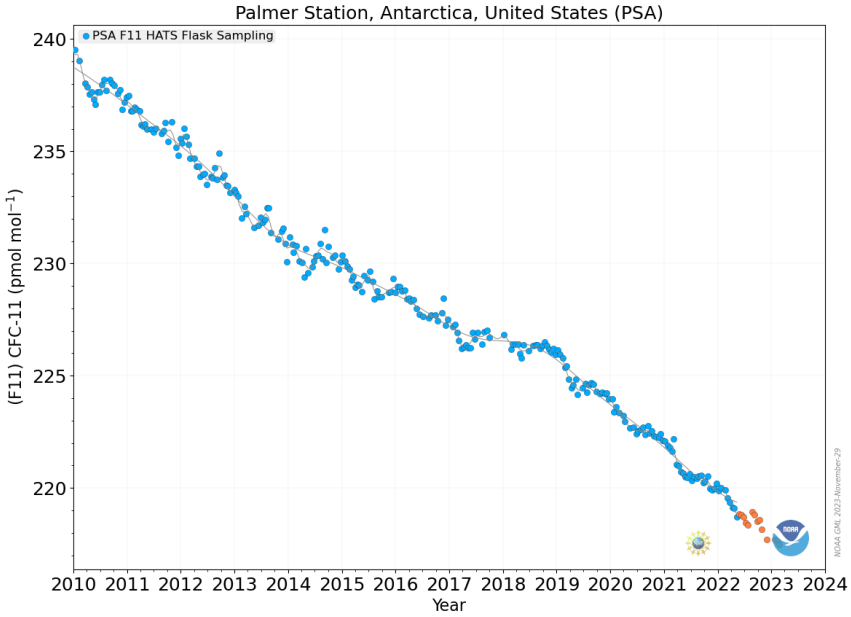

Figure 14. *CFC-11 levels at Palmer Station dating back to 2010, one of the Halocarbon and Trace Gases measured at Palmer Station. Orange dots are preliminary data.*

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.

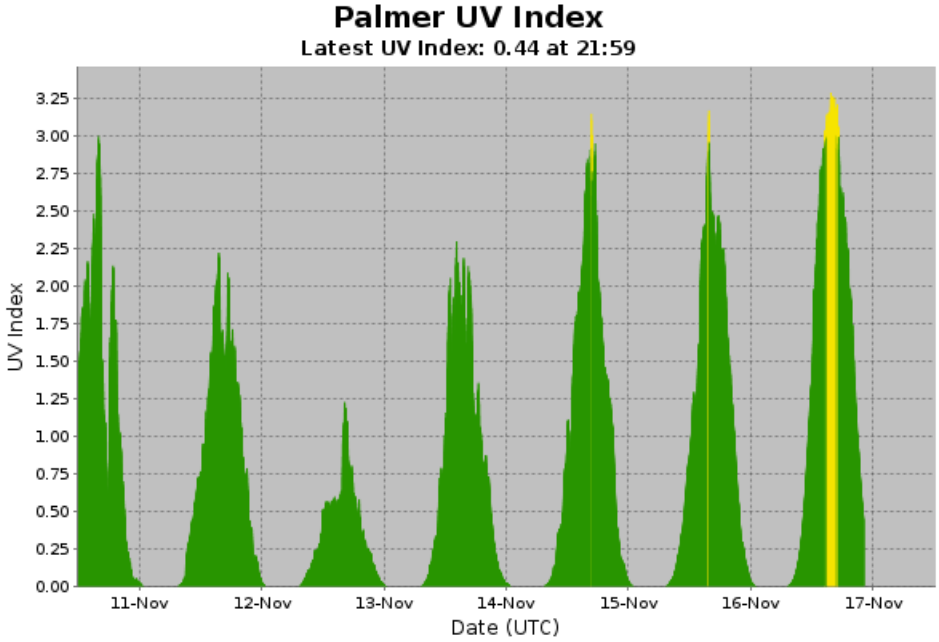

Figure 15. *UV index generated from the GUV-511 radiometer in real time.*

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 Absolute Scan was performed on November 5 and November 20 without issues. The system suffered a 4 day outage during the power outage in early October and successfully returned to normal operation when power was stable. 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.

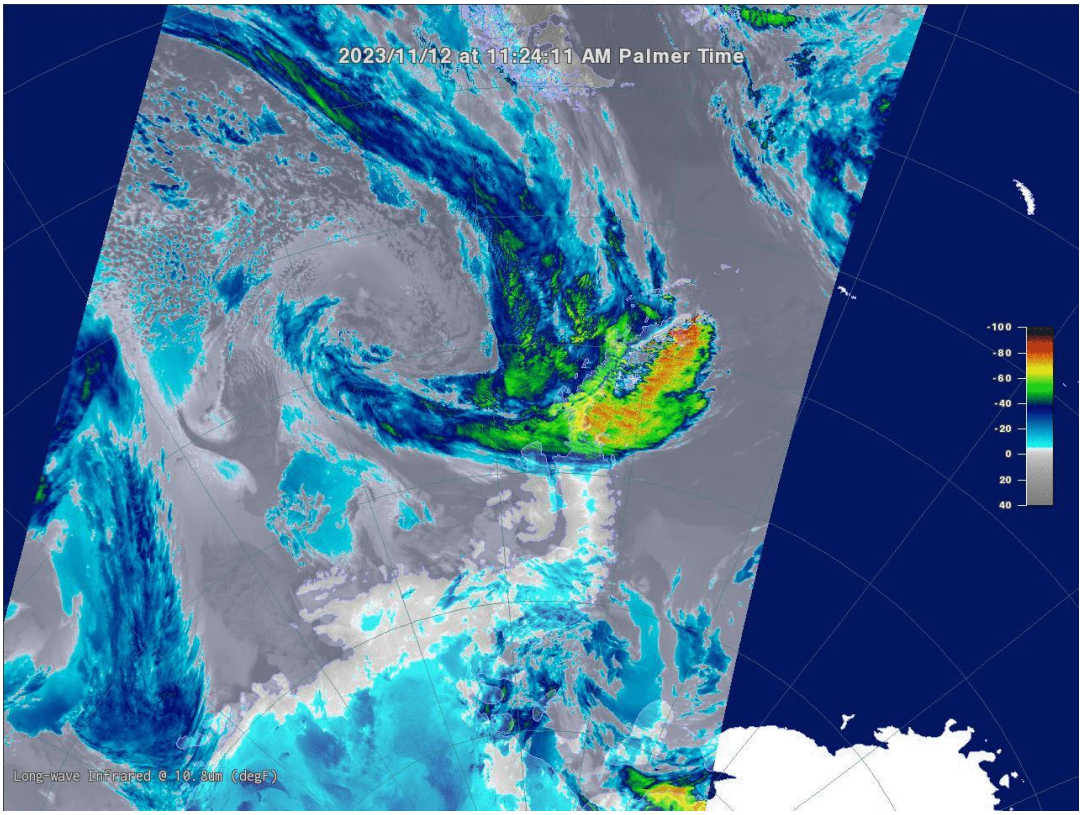

Figure 16. *NOAA-18* November *12 satellite pass*

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 operated normally this month.

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/.

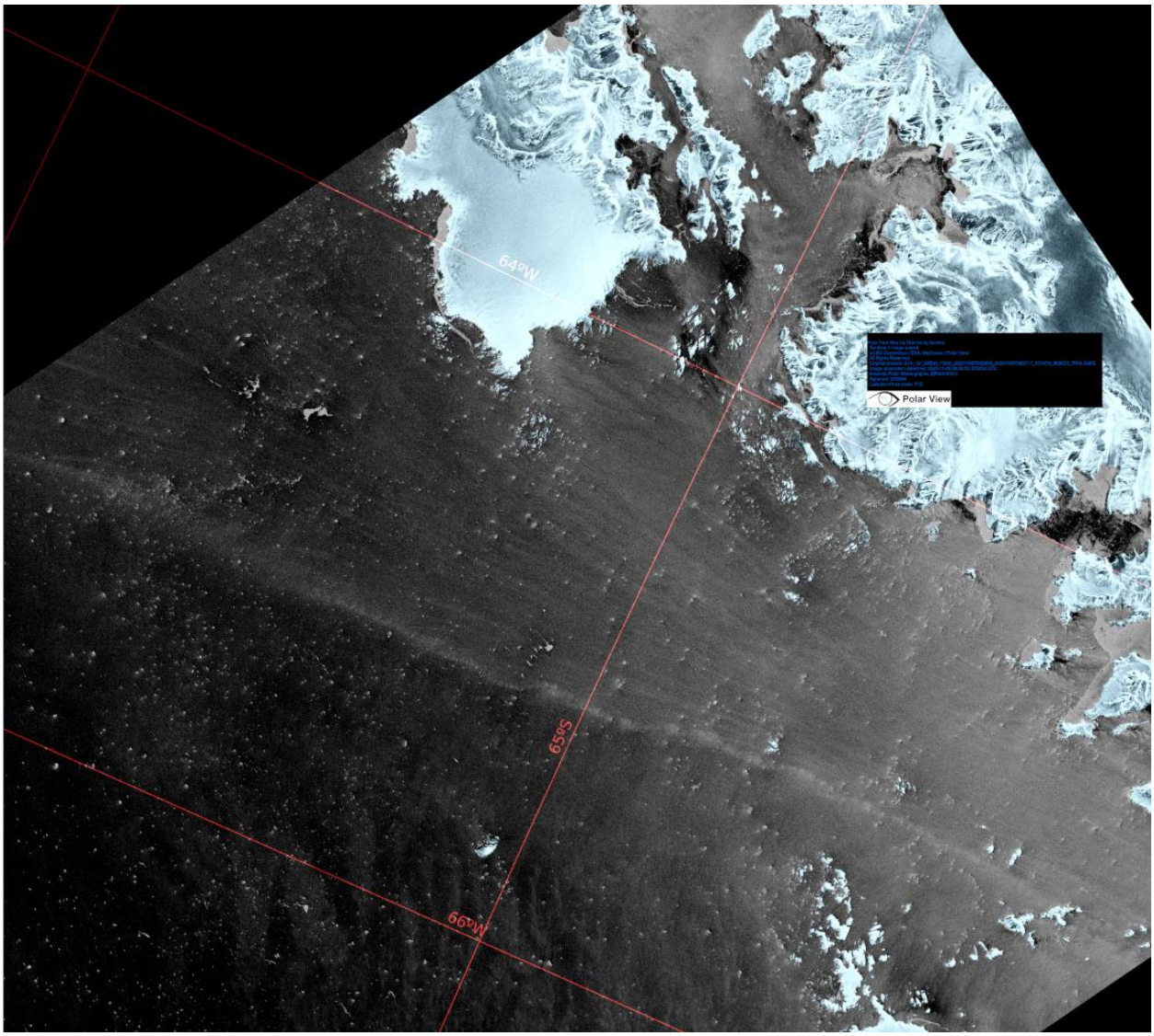

Figure 17. *Sentinel 1 Imagery from November 5, 2023 – Showing the vast quantity of exceptionally large ice bergs in the greater Anvers area. Source: Polar View*

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 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 November, 2023

Temperature
Average: -0.9 °C / 30.4 °F
Maximum: 4.4 °C / 39.92 °F on 28 Nov 14:46
Minimum: -6.7 °C / 19.94 °F on 2 Nov 09:38
Air Pressure
Average: 977.8 mb
Maximum: 997.5 mb on 19 Nov 10:53
Minimum: 960.7 mb on 12 Nov 21:23
Wind
Average: 15 knots / 17.3 mph
Peak (5 Sec Gust): 66 knots / 75 mph on 12 Nov 13:33 from NE (50 deg)
Prevailing Direction for Month: NNE
Surface
Total Rainfall: 87.4 mm / 3.44 in
Total Snowfall: 17 cm / 6.6 in
Greatest Depth at Snow Stake: 136.8 cm / 53.4 in
WMO Sea Ice Observation: 6-10 bergs, bergy bits, growlers, brash ice
Average Sea Surface Temperature: -0.73 °C / 30.7 °F