PALMER STATION MONTHLY SCIENCE REPORT

November 2022

What a difference a month can make. RHIB Hadar shown with a snowy Bonaparte Point in the background the first week of November, whereas three weeks later nearly all the snow is gone. *Image Credits: Hannah James*

NEWS FROM THE LAB

Hannah James, Summer Laboratory Supervisor

November came and went with a flurry of activities in BioLab, Terra Lab, and on the surrounding waters. The R/V Nathaniel B. Palmer docked at the Palmer Pier November 15th, delivering three of the C-013 (Cimino) team members as well as a resupply of Antarctic krill for the B-198-P (Weissburg) team. The B-198-P (Weissburg) team was incredibly productive with all of their experiments in the Aquarium spaces throughout the month. And although the weather didn't cooperate for as many days as a field science team hopes and wishes for the LTER groups were able to get out to sample water, survey birds, and quantify the return of many marine mammals. Individual group reports are below; things are in full summer mode here on station.

B-198-P: INDIVIDIAL BASED APPROACHES TO UNDERSTANDING KRILL DISTRIBUTIONS AND AGGREGATIONS

Dr. Marc Weissburg, Professor, School of Biological Sciences, Georgia Institute of Technology

Personnel on station: Dr. Marc Weissburg, Dr. David Fields, Dr. Nicole Hellessey, and Carlyn Scott

The goal of the work is to investigate drivers of individual behavior of krill. We plan to apply the findings to understand the organization and disorganization of large krill swarms. Krill net tows on the R/V Nathaniel B Palmer (Figure 1) during November resupplied us with a large number of adult animals, which were successfully transferred to Palmer Station. This allowed us to nearly complete our work on each of the three components (behavior of krill in response to horizontal flows and interactions with light and food odor; krill responses to vertical flows and interactions; krill schooling behavior) during the reporting period. Grantee personnel working on the C-013 (Cimino) project (Helena Dodge, Darren Roberts and Megan Roberts) were able to supply us with penguin guano, which we used to investigate how predator scent affected krill swimming.

Figure 1: *Krill being transferred from the NBP to the Palmer Station aquarium room by Palmer station science support staff. Image Credits- Marc Weissburg.*

The annular flume used to produce krill schools was set up with the 7-camera recording system, flow and light levels calibrated, and schooling behavior elicited in groups of 700-1200 krill. (Figure 2). Groups of krill were tested in response to annular flow at 0.6-6 cm s-1 light (30 m depth) and dark conditions, with chlorophyll concentrations of 16-18 µg chlorophyll L-1, which are characteristic of high density plankton blooms. These experiments also altered krill density from roughly 7 to 1.2 animals L-1, which will allow us to investigate how krill density affects schooling behavior, particularly school coherence and structure. The goal is to reveal how animals distribute themselves in a school under different conditions to enable better acoustic sampling of krill abundance, allowing more effective management of krill populations.

Figure 2: *Grantees Carlyn Scott and Dr. David Fields assembling the annular flume used to produce krill schooling (left), and for experimental trials on krill schooling behavior (right). Image Credits: Dr. Marc Weissburg*

The horizontal flume (Figure 3) has been used to obtain krill responses to flows from 0-8 cm s-1 in both light and dark conditions, and in chlorophyll (food) levels typical of typical ocean

plankton levels (1-3 µg chlorophyll L-1), and plankton early, mid and full bloom conditions; 3-6, 9-12; 15-20 µg chlorophyll L-1, respectively) using 4-6 krill each. We will move on to investigating how penguin odor affects responses to flow and food in the last phase of our study. Controlled lighting allows us to produce different intensities characteristic of krill at surface and at darkened conditions at depth, with spectral measurements supplying exact values.

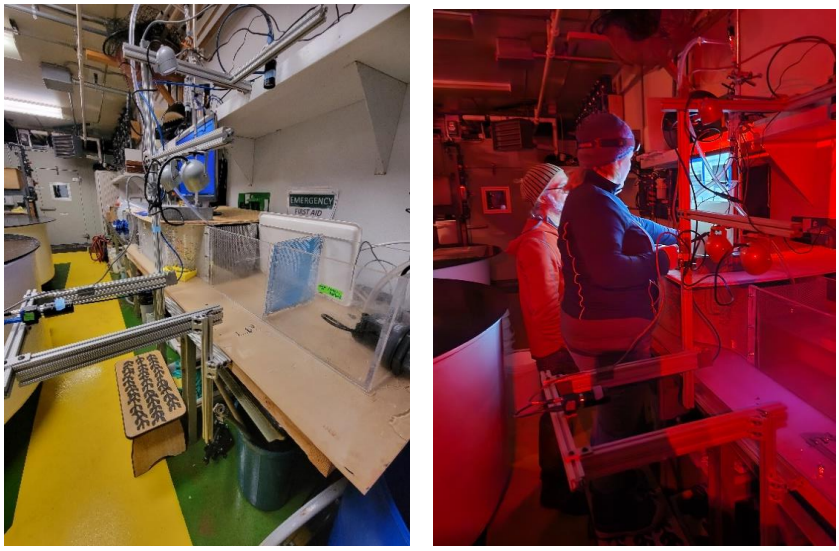

Figure 3: *Horizontal flume used to test small groups of krill in controlled flow, chlorophyll and light levels (left), and grantees Dr. David Fields and Dr. Nicole Hellessey performing trials in darkened conditions. Image credits: Dr. Marc Weissburg*

The setup records krill through time in horizontal and vertical planes to furnish x, y, z coordinates of swimming animals (Figure 4), which allows us to parameterize krill behavioral responses to these conditions once data have been fully analyzed off-site. The reconstructed 3D paths (Figure 5) are used to determine swimming speed, turning, body orientation, and other variables. The goal is to understand more clearly how krill respond to different conditions of flow, light, food, and predator cues to better predict their movements and habitat preferences.

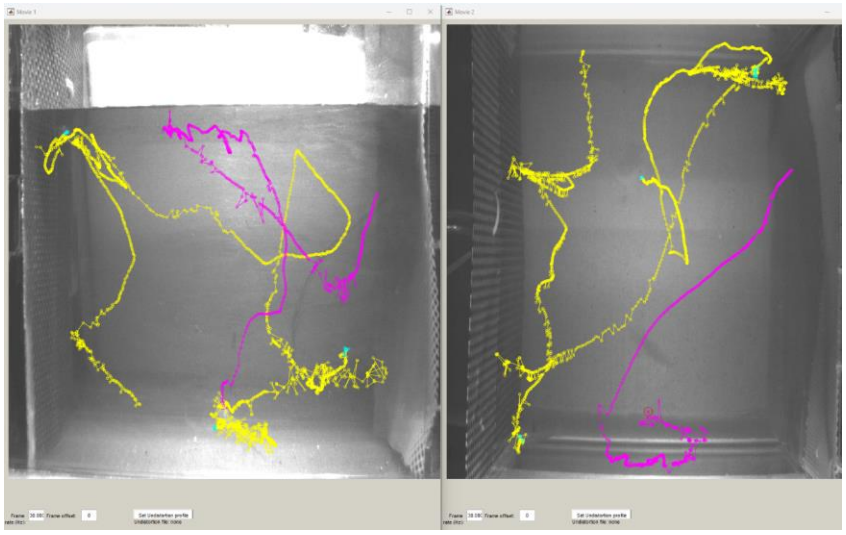

Figure 4: *Tracks of two krill (pink, yellow) as recorded in the flume at 3 cm s-1 flow and 5.5 ug chlorophyll L-1. The loopy nature of the tracks suggests area restricted search for food. The left panel show the x, z plane and the right panel the x, y plane*

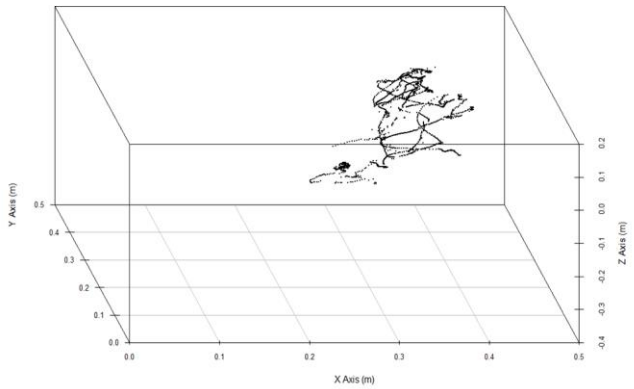

Figure 5: *3-Dimensional reconstructed track of a swimming krill (Track 1 from Figure 6)*

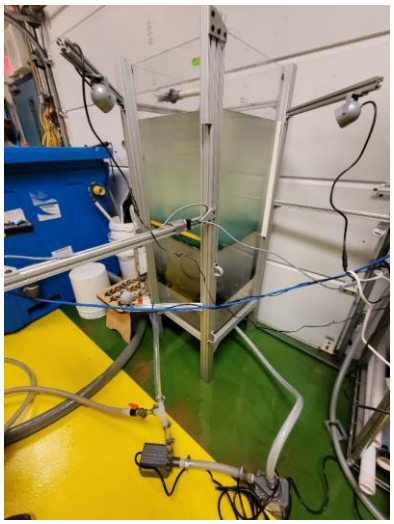

Figure 6: *Vertical flume used to test small groups of krill in controlled flow, chlorophyll and light levels Image credit: Marc Weissburg.*

We constructed a vertical flume (Figure 6), with the help of ASC staff, which was crucial in allowing us to meet our objectives. The device we had intended to use were delayed in transport due to logistical problems and did not arrive until mid-November, which was too late. However, using locally available materials in Chile and at Palmer Station, as well as station fabrication services, we were able to construct a new device (Figure 6) capable of up- and downward directed flows from 1.5-3.5 mm s-1, which are characteristic of ocean conditions. We have completed a full set of roughly 120 trials using this device, testing all possible combinations of two flow speeds (1.5 vs 3.5 mm s-1), up- vs downward directed currents, light vs. dark, and low (1-3), medium (6-8) and high (16-20 µg chl a L-1) with and without penguin guano (100 mg L-1; Figure 7). Once we have processed the data off site, these studies will add important insights into how krill select habitats to balance conflicting concerns of obtaining food vs. avoiding predators. In turn, this leads to increased ability to monitor krill populations, understand how penguin predators and krill prey interact, and identify important habitats for both penguins and krill.

Figure 7: *Grantee Nicole Hellessey weighs out penguin guano to create the guano slurry used to prepare guano treatments during the vertical flume trials. The concentration shown here is roughly 10 g L-1, or 100 fold greater than the concentrations used in the trials. Image Credit: Dr. David Fields*

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

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

C-013-P personnel arrived at Palmer Station on November 15. High winds reduced overall field days in November, but we were still able to access study sites for a total of eight days in the last half of the month.

Field work this month began with breeding chronology studies on a subset of Adélie nests on Torgersen and Humble Islands. A portion of Adélie penguin nests were sampled at the 1-egg stage to obtain adult body condition and egg morphometric data. This was the first time in three years we have been able to access this measurement. The Boat House and the Palmer community played a major role in attaining this data. We had not been able to complete the Boat Operator Training before the measurement window opened, and the Boat House personnel and members of the community gave us rides to the study sites allowing access to this data. 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.

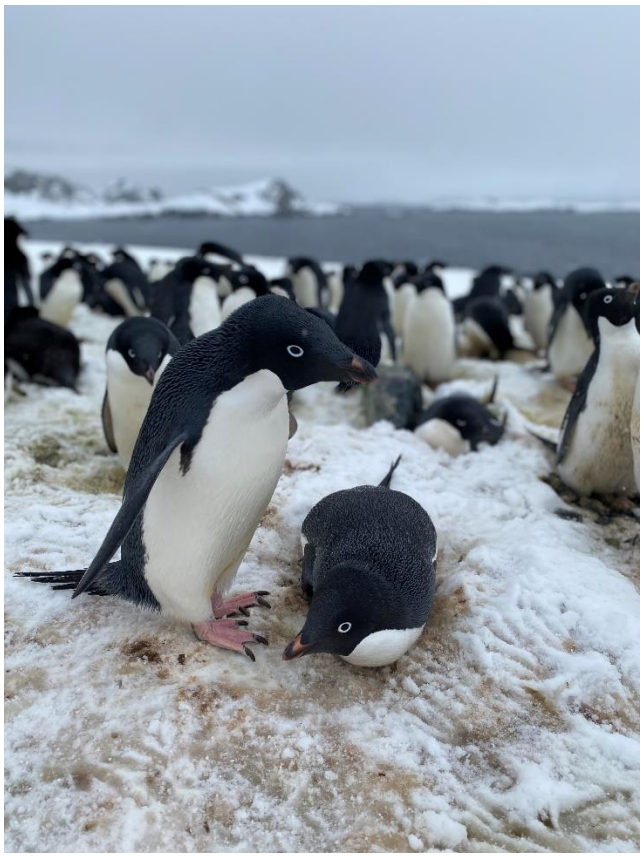

Figure 8: *A pair of Adélie penguins in the colony at Torgersen Island. Photo credit: Megan Roberts*

The Penguin Acoustic Population Estimation and Phenology Project began in November. This study is being led by Dr. Laura Kloepper from the University of New Hampshire with assistance from our team. This pilot project aims to assess breeding phenology and population dynamics in select Adélie penguin colonies at Humble and Torgersen Islands. Our team set up a number of acoustic recording devices near select colonies at Humble and Torgersen Islands.

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.

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, Cormorant, and Elephant Rocks. Additionally, the effort to recover over winter tags from Giant petrels at Elephant Rocks began in November. Deployment of GPS tags began on Giant petrels in November and will continue for the majority of the summer.

Figure 9: *Giant petrel with GPS tracker at Elephant Rocks. Photo 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. Minke whales were the most abundant whale observed in November. We observed evidence of Elephant seal pupping in the local group of islands.

Figure 10: *Minke whales near Shortcut Island. Photo credit: Megan Roberts*

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 impressive logistic support. We would also like to thank the Boat House personnel, Barb Krasinski, Matt Cabell, and Heather Jackson for extensive help upon arrival to access our study sites from the moment we arrived.

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

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

Despite rough weather, November was a productive month for the Schofield lab. Lab setup and instrument preparations were completed in the end of October, allowing us to collect samples throughout the entire month. Through that period we were able to refine our sampling protocols and narrow down best practices for sampling efficiency, getting into the swing of things with our different sampling schemes. In the later weeks, we were also able to begin preparing for collaborative transects and light experiments, which should begin right into December.

Figure 11: *C-019-P grantee Malarie O'Brien onboard RHIB Hadar, transiting to Station E for Bi-Weekly sampling (photo credit Mackenzie Curtice*)

About halfway through the month Malarie O'Brien joined the lab to assist in sampling. Malarie is currently a 2nd-year master's student in the Master of Operational Oceanography Program (MOOP) at Rutgers. Malarie joined MOOP after working as a civilian oceanographer for the U.S. Navy at the Naval Oceanographic Office. She has conducted various oceanographic surveys aboard U.S. Navy T-AGS vessels. While this is her first

time conducting fieldwork in Antarctica, she brings years of experience using CTD and other Physical Oceanography instrumentation. She is eager to gain new field and lab experiences, and hopes to learn as much as she can about polar operations while she is here at Palmer.

Figure 12: : *Sneha records metadata on log sheets as bottles of water collected from Station E filter on vacuum filtration rigs (photo credit Malarie O'Brien)*

With science fully underway, the Schofield lab has set out three separate sampling schemes for core LTER measurements. This includes daily, weekly, and bi-weekly sampling. Daily sampling includes water collection from the Palmer Station seawater pumphouse, which draws water from nearby Arthur Harbor. For this scheme, we focus on straightforward measurements of phytoplankton community health, composition, and particle characteristics using a series of fluorometers and an Imaging Flow CytoBot (IFCB). Our weekly sampling consists of the same measurements as daily sampling, but with the addition of filtering, where we collect plant biomass on filters for later analysis of community DNA, light absorption, and plant pigments back in the US. We conduct our weekly sampling every Wednesday.

Figure 13*: ASC Fleet Captain Matt Cabell (left) and C-019 grantee Sneha Sivaram (right) transport a CTD Rosette back to shore in a zodiac, avoiding incoming ice as the winds shift. (Photo credit Malarie O'Brien)*

Figure 14: *ASC Hazardous Waste Technician Travis Groh (center) and Fleet Captain Matt Cabell (inside the boat cabin) guide Hadar, the Rigid Hull Inflatable Boat (RHIB), onto its trailer for routine weekly maintenance amid glacial brash ice. (Photo credit Heather Jackson)*

Bi-weekly sampling, which is the longest-running sampling scheme for the lab, consists of water collection on Mondays and Thursdays, using a Rigid Hull Inflatable Boat (RHIB; pictured) to travel out to sea collect water using an A-Frame, winch, and a CTD Rosette (a programmable water collection instrument). The CTD Rosette allows us to collect a vertical profile of physical water properties (i.e., temperature, salt content, etc.) and select specific depths to collect water from. For bi-weekly sampling, we collect the same full suite of measurements as we do for daily and weekly sampling, but at a different location. We collect our water at Station E, a site located on the edge of Palmer Deep Canyon that has been sampled every year for 25+ years.

Figure 15: *C-045 (Van Mooy) grantee Mackenzie Curtice checks the hardware components of the CTD Rosette onboard Hadar as the LTER group prepares to head out to Station E. (Photo credit Carlyn Scott)*

Weather over the month has certainly been an issue, with high winds and large swells preventing our group from getting out to Station E on many occasions. But despite bad weather, the LTER team has managed to conduct 24 separate sampling events over 30 days! We owe this progress to the continuous energy given by the dedicated boat operators and science support team. Without their help, the work we completed this month would not be possible, and we are truly grateful for their contributions.

As the Schofield Lab heads into December, we look forward to continuing our current progress. Next month brings two additional sampling schemes to our roster (acoustic transects and light experiments) and collaborators down to the ice to make it a jam-packed end of the year. We are excited to start these projects, further our collaborative efforts, and synthesize the data we've collected so far as we start heading into the peak summer months.

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

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

Personnel on station: Mackenzie Curtice

The Van Mooy lab group is thrilled to complete another month of our research at Palmer Station. This month has flown by with all the productive sampling and processing the lab has encountered. Living at Palmer Station with unpredictable weather has helped the lab groups realize how important it is to collect samples cooperatively with any weather window. The weather can be unpredictable but between the C-045 Van Mooy group and the C-019 Schofield group, we have all worked together to take advantage of the nice sampling days on the water. Field sampling of oxygen isotopes, nutrients, and flow cytometry has continued to be collected at Station E. The remaining 21L of water samples collected are filtered back in the lab as soon as possible. Using a vacuum pump system, the water is filtered through durapore filters to capture the microorganisms that live in the water column. Once the water fully drains through the filter it can then be transferred into storage until it is time to analyze those samples.

Figure 16: *Mackenzie Curtice (left, C-045-P grantee), works with Sneha Sivaram (right, C-019-P grantee) in Lab 3 to look over data gathered from sampling. The filter rig is prepped and ready to filter more seawater from Station E. (photo credit Dr. Nicole Hellessey)*

The Nathaniel B. Palmer (NBP) came into port this month for a few days to drop off more Palmer residents but sadly take a few away for their voyage to New Zealand. The NBP also dropped off an added instrument for the Van Mooy lab. The Flow Cytometer has been set up in Lab 3 and will be ready to process samples shortly. The labs have been remarkably busy with experiments and sampling happening around the station. The Long-Term Ecological Research (LTER) cruise is approaching, and with that in mind there will be many more moving parts around the building and labs. Lab 3 has been busy every week and is looking forward to another successful month of research at Palmer Station!

The science community would not be able to have completed all this research and sampling without the help from the support group on station and those helping virtually. The Van Mooy group would like to thank everyone for their cooperation and support this month. We are looking forward to another productive month in December!

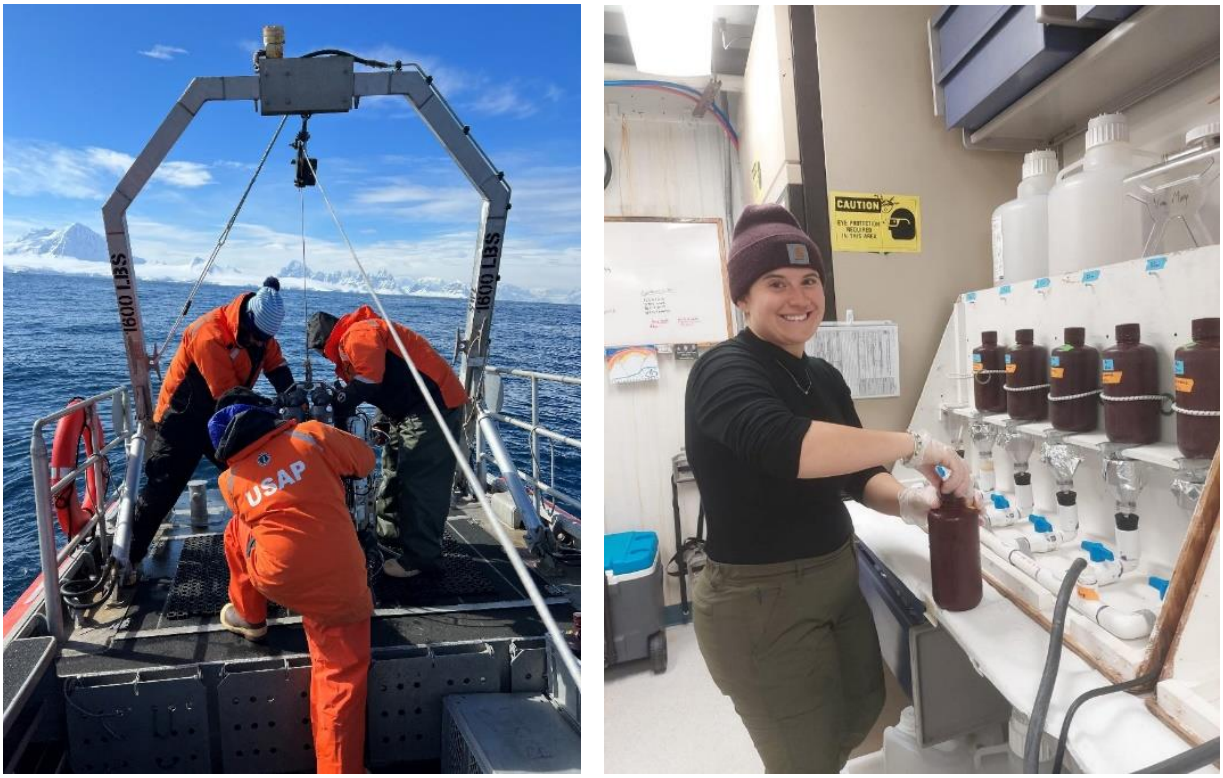

Figure 17: ***Left****: Mackenzie Curtice (C-045-P), Sneha Sivaram (C-019-P), and Lance Roth (ASC Instrument Technician) prepare to deploy the CTD rosette into the water at Station E to collect both science groups' water for the day. Photo credit Matt Cabell.* ***Right****: C-045-P (Van Mooy) grantee Mackenzie Curtice prepares to filter the seawater collected from Station E. Photo credit Dr. David Fields.*

PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT
November 2022
Marissa Goerke

Evidence of high snow accumulation, November 10, 2022. *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.

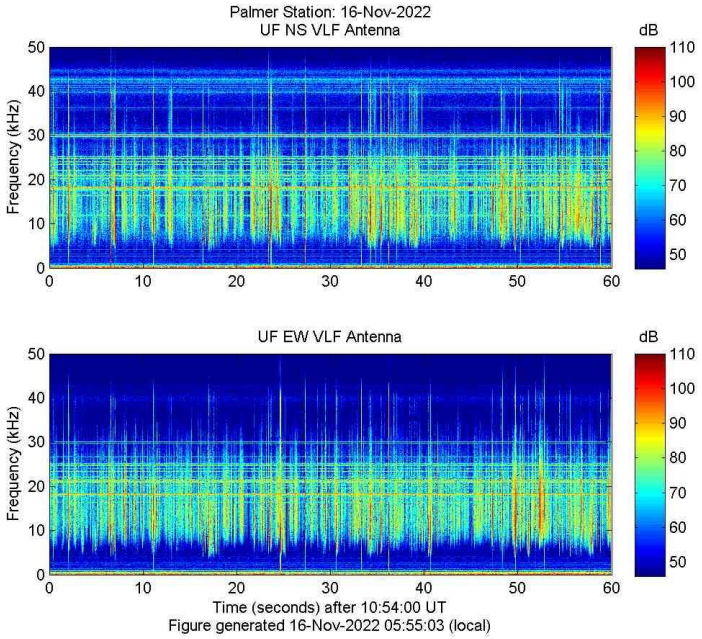

Figure 18. *Real-Time broadband VLF Spectrogram from Palmer Station, Antarctica.*

Both the Extremely Low Frequency and Very Low Frequency systems operated well this month. The full hard drives were swapped out on November 30. The spectrograms were reviewed daily and bi-weekly antenna inspections were done as weather allowed.

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

A-111-P: SAMBA MAGNETOMETER

Andrew Gerrard, Principal Investigator, New Jersey Institute of Technology

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

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

The magnetometer was originally installed at Palmer in 2005, and a replacement installed in April of 2008. In 2017 the project was taken over by Andrew Gerrard. On February 27th, 2017 the USAP IT blocked all northbound VPN traffic under a larger umbrella of blocking all northbound encrypted-tunnel traffic. Since that time there has been much discussion, but the magnetometer is still considered a security vulnerability. The Research Associate has been working with the home institution at the University of California, Los Angeles to resolve this

issue. As of September 30th, 2020 at 7:45am local time, the magnetometer was removed from the network. The instrumentation and computer are still operational. Data will continue to be collected and stored locally. The RA is working with the IT department to send out the data to UCLA when requested. More information can be found at: http://magnetometers.bc.edu/index.php/palmer.

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

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

Two of the three sites' transmitter and receivers were shipped north on LMG21-11. The system is still continuously collecting data from the remaining site. The PI has deemed the data useful information from the single site.

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

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

Palmer's seismic station, code named PMSA, is part of the Global Seismic Network (GSN), a collection of 150+ sites worldwide, operating under the aegis of the Incorporated Research Institutions for Seismology (IRIS), and managed by the United States Geological Survey's Albuquerque Seismological Laboratory (ASL). The site was installed in March 1993. As of August 2006, PMSA is also used as an ancillary seismic system for the CTBT/IMS installation; CTBT-specific protocols for the seismic system are covered in the CTBT (T-998) section this document.

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

By examining time of arrival, azimuth, magnitude, frequency and wave type of the incoming waves, seismologists can determine the location, depth of focus, magnitude, type of faulting that

occurred, ground acceleration in gravitational force and the structure of the medium (the earth) through which the waves traveled to reach the station. The Research Associate operates and maintains on-site equipment for the project.

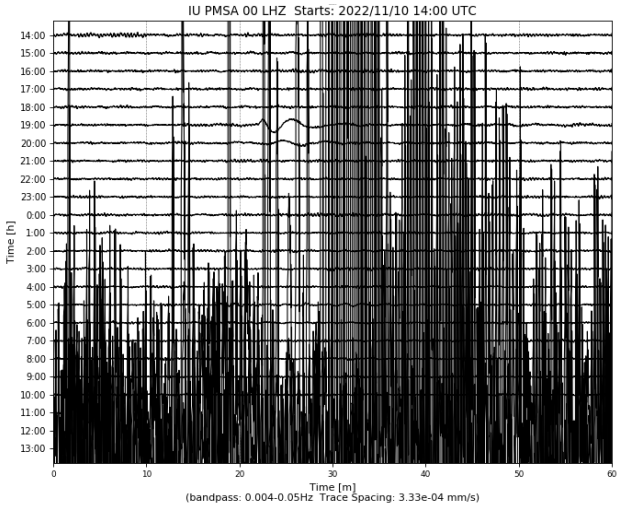

Figure 19: ***An earthquakes occurring on November 11, 2022 in the Tonga Region.***

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

O-264-P: A STUDY OF ATMOSPHERIC OXYGEN VARIABILITY IN RELATION TO ANNUAL DECADAL VARIATIONS IN TERRESTRIAL AND MARINE ECOSYSTEMS.

Ralph Keeling, Principal Investigator, Scripps Institution of Oceanography

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

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

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

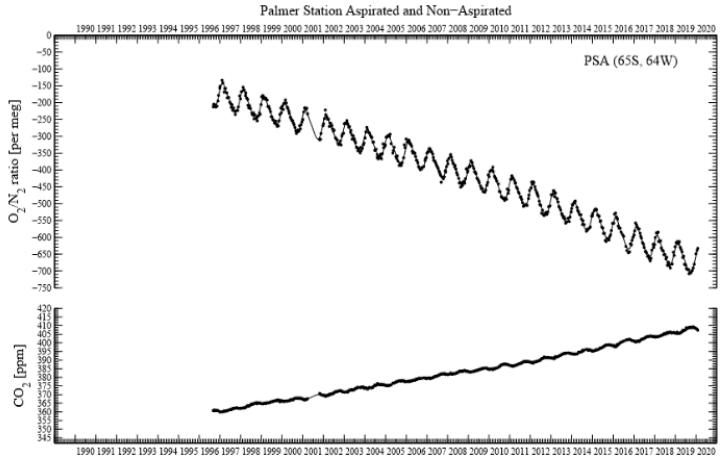

Figure 20: Historical plot of $\mathbf{O_2/N_2}$ ratio per meg and $\mathbf{CO_2}$ ppm updated on July 29, 2020.

Air samples were collected on October 31 and November 15. Wind conditions must equal or exceed 5 knots from a direction between 5° to 205° constantly for over an hour with no interference from human traffic on foot or in vessels. These air samples will be shipped to Scripps Institution of Oceanography in California for analysis. More information and data can be found at: https://scrippso2.ucsd.edu/osub2sub-data.html.

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

Don Neff and Steve Montzka, Principal Investigators, National Oceanic and Atmospheric Administration / Global Monitoring Division; Boulder, CO

The NOAA ESRL Carbon Cycle Greenhouse Gases (CCGG) group makes ongoing discrete measurements to document the spatial and temporal distributions of carbon-cycle gases and provide essential constraints to our understanding of the global carbon cycle. The Halocarbons and other Atmospheric Trace Species (HATS) group quantifies the distributions and magnitudes of the sources and sinks for atmospheric nitrous oxide (N_2O) and halogen containing compounds. The Research Associate collects weekly air samples for the CCGG group and fortnightly samples for the HATS group. Wind must be between 5 and 15 knots and consistently blow from one sector with no people, equipment, or boats upwind of the sampling location.

Carbon Cycle Greenhouse Gases (CCGG) samples were collected on November 7, November 15, November 22, and November 28 during favorable wind conditions. More information and data for the Carbon Cycle group can be found at: https://www.esrl.noaa.gov/gmd/ccgg/trends/.

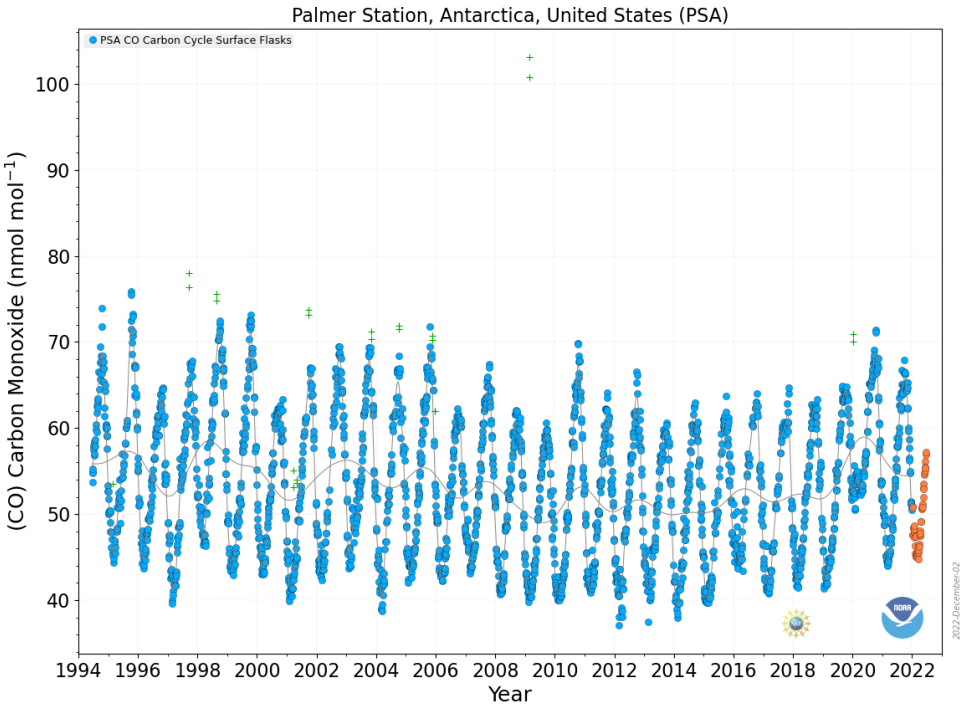

Figure 21: Carbon Monoxide (CO) levels at Palmer Station dating back to 1994. Orange dots are preliminary data

Halocarbons and other Atmospheric Trace Species (HATS) samples were collected on November 16 and November 29 during favorable wind conditions. You can visit https://www.esrl.noaa.gov/gmd/hats/ for more information about the Halocarbons and other Atmospheric Trace Species group.

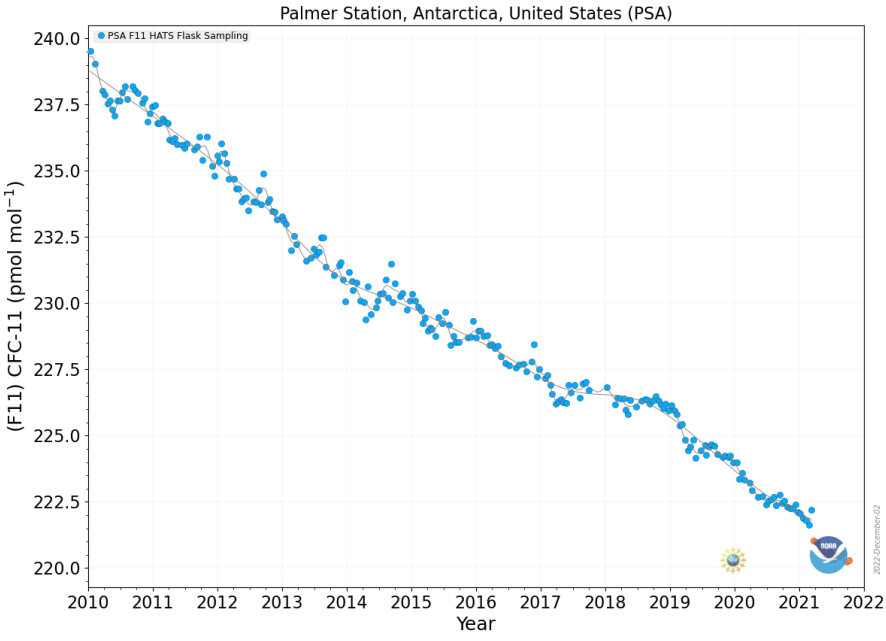

Figure 22: CFC-11 (CCl_3F) levels at Palmer Station dating back to 2010, one of the

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

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

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

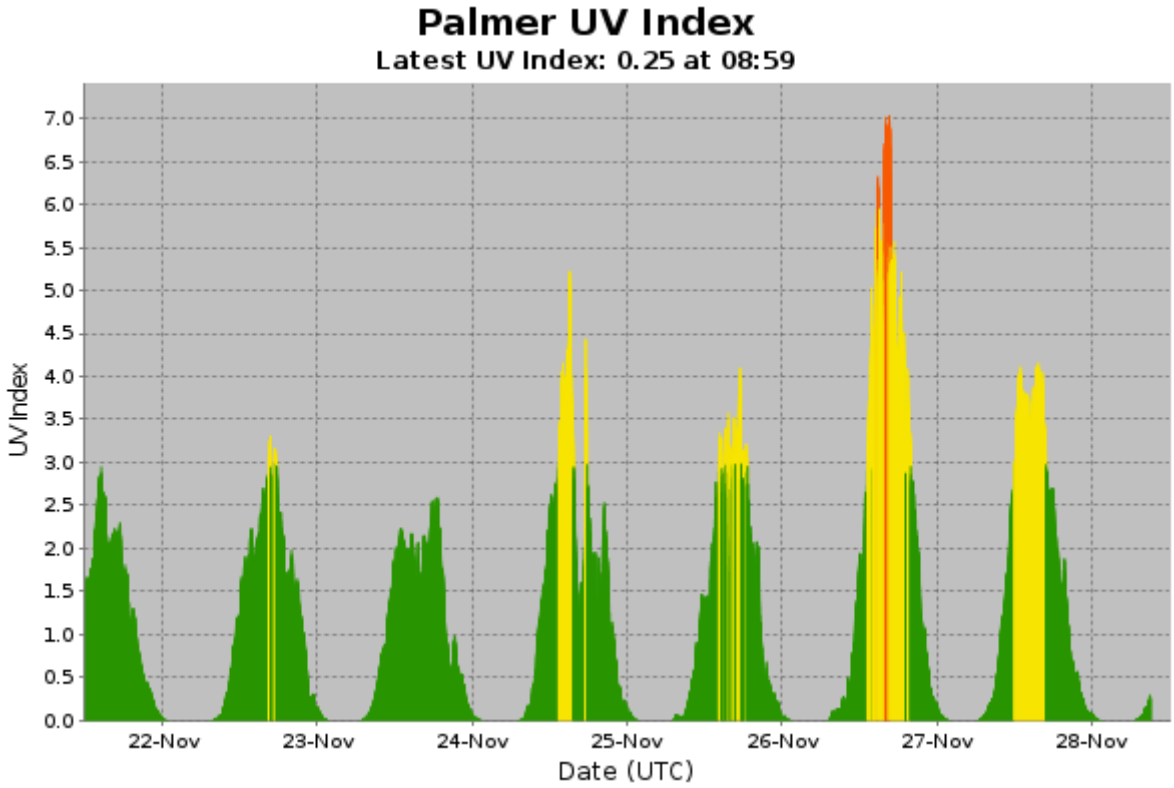

Figure 23: UV index generated from the GUV-511 radiometer in real time.

The log was filled out and collectors were cleaned on a daily basis. Once a week level checks were performed to confirm that the instrumentation was within +/- 0.2 degrees. The weekly log was sent out each Monday and bi-weekly SUV-100 UV Absolute Scans were performed on November 5 and November 19 without issues. The highest UV levels for the November were reached on November 27 at 7.0 on the UV index.
For more information visit: https://esrl.noaa.gov/gmd/grad/antuv/.

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

TeraScan is an integrated system of hardware and software designed for automated reception of data from meteorological/environmental satellites and for processing the data into images and data overlays. The system collects, processes, and archives DMSP and NOAA satellite telemetry, capturing approximately 25-30 passes per day. The data files for these images and overlays are of a special format called TeraScan Data Format (TDF). The Research Associate operates and maintains on-site equipment for the project. The TeraScan weather and ice imagery is used for both research and station operations.

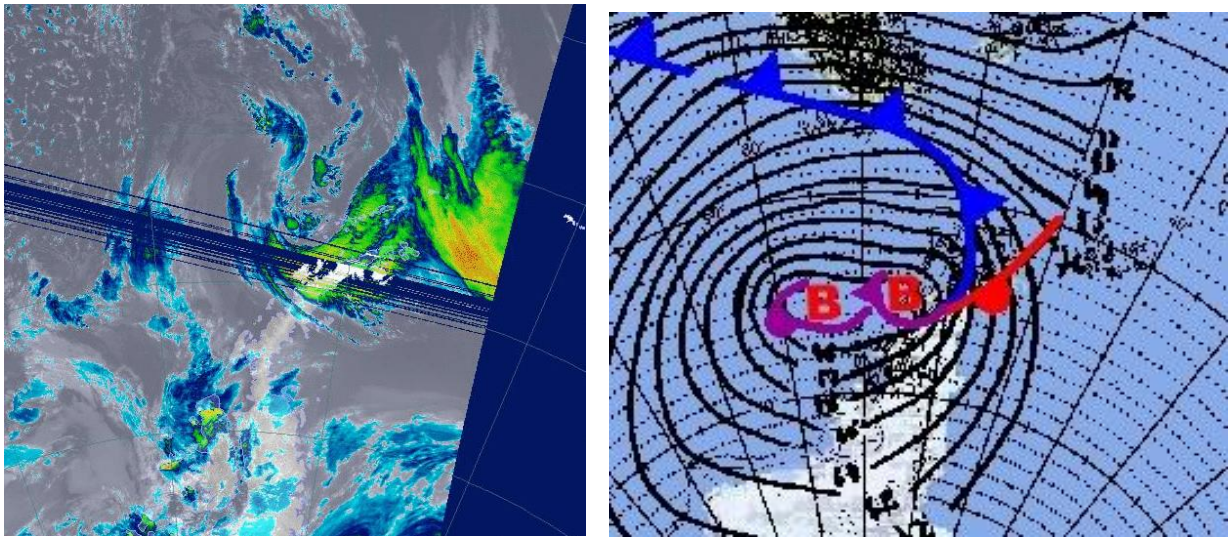

Figure 24. *METOP-3 November-23 satellite pass (left) explained by the Chilean Navy Meteorological Map (right).*

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

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

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

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

JPL/NASA is contracted to maintain the system, and they have sub-contracted to UNAVCO. While operation and maintenance of the GPS/CORS base station is the responsibility of the

Research Associate, it is available for grantees who wish to use the roving systems and/or differential post-processing using data from the fixed reference station. Users are expected to have proper training prior to deployment to Palmer. The Research Associate may offer support to visiting grantees at their discretion.

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

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

The Comprehensive Nuclear Test Ban Treaty (CTBT) bans all nuclear explosions. Although not ratified, the 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. Additional details about the treaty and monitoring stations can be found on the CTBTO web site, http://ctbto.org/.

PHYSICAL OCEANOGRAPHY

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

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

Observations of sea ice around station were made daily. Tide level, sea water conductivity, and sea water temperature data is archived on the AMRC website: http://amrc.ssec.wisc.edu/data/ftp/pub/palmer/.

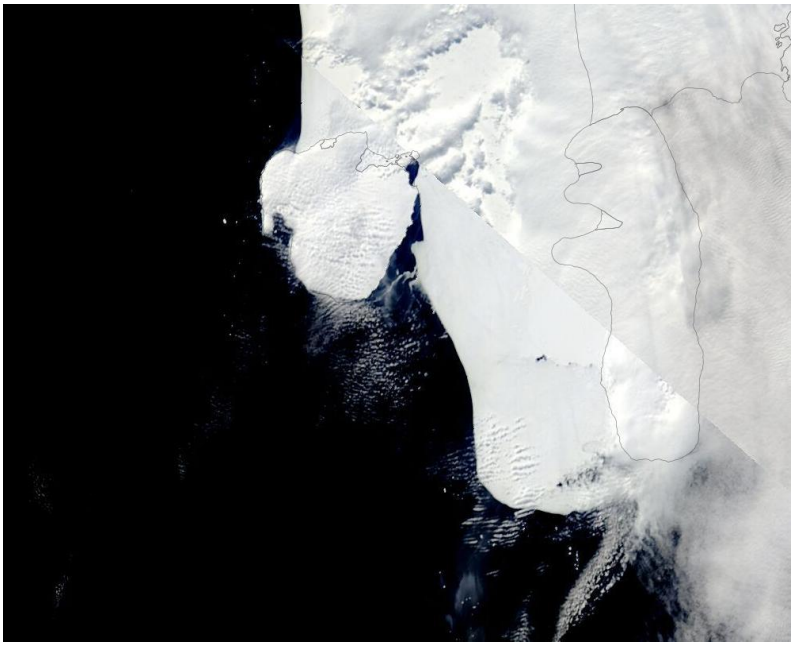

Figure 25. *Charcot Island ice free, November 15 2022.*
Source: EOSDIS Worldview

METEOROLOGY
Mike Carmody, Principal Investigator, United States Antarctic Program

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

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

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

The local weather station (PAWS) operated well throughout the month. All three remote AWS sites require maintenance so their functionality this season were sporadic at best. The average wind speed for the month was noticeably higher than average. November was a month of high accumulation and quick melt. This was the wettest November on record. 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, 2022

Temperature
Average: .7 °C / 33.2 °F
Maximum: 5.6 °C / 42.08 °F on 17 Nov 21:10
Minimum: -3.5 °C / 25.7 °F on 5 Nov 07:51
Air Pressure
Average: 974.3 mb
Maximum: 992.9 mb on 5 Nov 08:05
Minimum: 939.6 mb on 30 Nov 10:34
Wind
Average: 19.4 knots / 22.3 mph
Peak (5 Sec Gust): 59 knots / 68 mph on 24 Nov 17:47 from NE (35 deg)
Prevailing Direction for Month: NNE
Surface
Total Rainfall: 199.4 mm / 7.85 in
Total Snowfall: 38 cm / 14.8 in
Greatest Depth at Snow Stake: 162.8 cm / 63.5 in
WMO Sea Ice Observation: 1-5 bergs, bergy bits, growlers, and brash ice
Average Sea Surface Temperature: -.43 °C / 31.2 °F