PALMER STATION MONTHLY SCIENCE REPORT

October 2022

A few of the krill caught for the B-198-P (Weissburg) season. *Image Credit: Hannah James*

NEWS FROM THE LAB
Hannah James, Summer Laboratory Supervisor

The Summer 2022-23 science season is officially underway at Palmer Station. The R/V Laurence M. Gould tied up to the pier on October 7th. It brought summer Antarctic Support Contract staff to swap out with the winter crew, as well as seven grantees to begin their Austral summer field science seasons. Much of the month of October was spent setting up lab spaces for the three on-site groups: C-019-P (Schofield), C-045-P (Van Mooy) and B-198-P (Weissburg). I'm happy to report that the BioLab and Aquarium laboratories are now buzzing with sampling, processing, and analysis by all three groups. Each project has a summary of their goals and accomplishments from the month in this report.

With the arrival of the summer crew, the B-459-P (Bernard) team, led by Dr. Kim Bernard, packed up their lab spaces, transferred samples onto the ship, and sailed north with the winter support staff on October 16th. I would like to extend my congratulations and a sincere thank you to the Bernard lab team and our fellow ASC winterovers for everything they did to keep Palmer Station running over the winter. A special thank you to our on-site science support staff, Angela Klemmedson, Nerissa Fisher, and Ben Rosen-Filardo. I would also like to welcome back Marissa Goerke (Research Associate), Lance Roth (Instrument Technician), for the Summer 2022-23 season, as well as Jamee Johnson (Peninsula Science & Technical Projects Manager), who is on-site with us until mid-November.

Although the calendar says we are heading into the summer season, the weather has remained more wintery than expected. Marissa Goerke details this later in the Research Associate section of this report, but higher winds and snowfall have remained consistent in our day-to-day lives here. Wildlife sightings are increasing each week: Adélie penguin colonies have returned to Torgersen and Humble islands, three sets of Weddell seal pups were born in Hero inlet, Elephant seal pups can be seen at Point Eight and on Elephant Seal Rocks, and Gentoos penguins have been frequenting the Point Eight shorelines. Giant Petrels, Sheathbills, Kelp Gulls, and Cormorants are commonly seen around station, and a few Skuas have been sighted in the area.

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: Quintin Diou-Cass and Sneha Sivaram

With the turnover of summer personnel and offloading of science equipment complete, the Schofield lab is excited to finally be back at Palmer Station for its 14th season of science! While the global pandemic and new pier construction have altered science operations over the past few years, the LTER and the Schofield lab are back at full force for 2022-2023, and there is much exciting science to be had.

The Schofield lab this season is helmed by Quintin Diou-Cass, a PhD candidate with Dr. Schofield, and Sneha Sivaram, a master's student at Université Laval in Quebec City, Canada. Quintin has been down to the Antarctic twice before, conducting sampling for the Schofield lab on Palmer Station, the R/V *Laurence M. Gould*, and the R/V *Nathaniel B. Palmer*. He is excited to once again be on the ice, collecting data for the time series and conducting new experiments in the lab. This is the first time down to the Antarctic for Sneha, a previous undergraduate of Rutgers and current master's student with Dr. Marcel Babin, but she has experience with polar ecosystems in the Arctic, where her master's thesis is focused. Her undergraduate research and master's research have been concentrated on phytoplankton ecology and biophysics. They will be joined later in the season by Rutgers masters students Malarie O'Brian (from November-December) and Michael Chen (from February-March).

After a foggy but beautifully calm crossing of the Drake Passage, the R/V LAURENCE M. GOULD arrived to Palmer Station in early October. In the first two weeks, Quintin and Sneha began unpacking, organizing, and setting up all the components of their lab. This included consolidating sampling supplies, unpacking instruments/equipment, storing chemicals, and solidifying sampling plans for the season. The team also took this time to become properly trained on safety and logistics for both boating and lab operations. In late October, the setup, calibration, and testing of instruments (6 in total!) was completed, and attention moved to preparation for sampling. This included reviews of instrument protocols, field sampling practice, and the setup of lab spaces for light experiments and primary production incubations. The work of the team this season will build on the work of many before them, driving a 30+ year time series even further.

Initiated in 1991, the LTER dataset has persisted over three decades to provide a complex narrative of phytoplankton community ecology, and ecological change, at Palmer Deep Canyon. To decipher, understand, and learn from what the phytoplankton community tells us, the Schofield team deploys a CTD rosette and optical instruments at Station E on the edge of Palmer Deep biweekly, measuring biophysical conditions and collecting water samples below the surface. These water samples are transported, processed, and filtered in the lab to gather critical data on phytoplankton community state and function. Filtered biomass is used to quantify pigment concentrations, identify metagenomic sequences, and measure absorption spectra; providing insights for community composition, community health, and ocean color satellites. Living samples of phytoplankton undergo three different techniques of fluorescence measurement, providing in-depth knowledge on their photosynthetic health, efficiency, and

adaptability. Algal cells are also run through an Imaging Flow CytoBot to produce pictures and particle characteristics of individual phytoplankton, providing a further look at community composition and biological state (i.e., big algae vs small algae). Finally, 24-hour incubation experiments with radioactive carbon (^{14}C) are done to track carbon uptake and incorporation, providing a means to calculate phytoplankton primary productivity and growth rates.

In addition to traditional time series sampling, the Schofield lab will also be conducting a series of light experiments on station. These will involve exposing cultures and natural communities of phytoplankton to differing light in the lab, recreating the natural intensity and variability of light found in the Antarctic surface ocean. Using comprehensive fluorometeric techniques as a method to characterize photophysiology, these experiments will paint a detailed picture of how (and at what rate) phytoplankton respond internally to their chaotic light environments. This will provide new insight on how the characteristics of phytoplankton ecology (growth, community composition, nutritional value, etc.) are impacted by light, and how well the algae can fight against changes in their light environment.

As in the previous season, the Schofield lab is looking forward to participating in collaborative projects with the Van Mooy, Steinberg, Cimino, and Friedlaender labs. With help from these groups, the Schofield team will conduct acoustic surveys in critical foraging areas, using an EK80 acoustic sensor, visual predator surveys, and intermittent CTD profiles. By working with the other science groups in the extended boating area and in Palmer Canyon, we can help reveal the interactions between the mixed layer depth, krill distributions, and penguin/whale foraging patterns.

The Schofield lab is extremely happy to be here and is looking forward to a fun, productive, and groundbreaking experience this season! Without the support of ASC staff and other science groups, the Schofield lab wouldn't be able to gather these amazing datasets. We appreciate and recognize everyone at Palmer Station and on the LMG for their incredible ongoing support with our lab considering their own busy schedules.

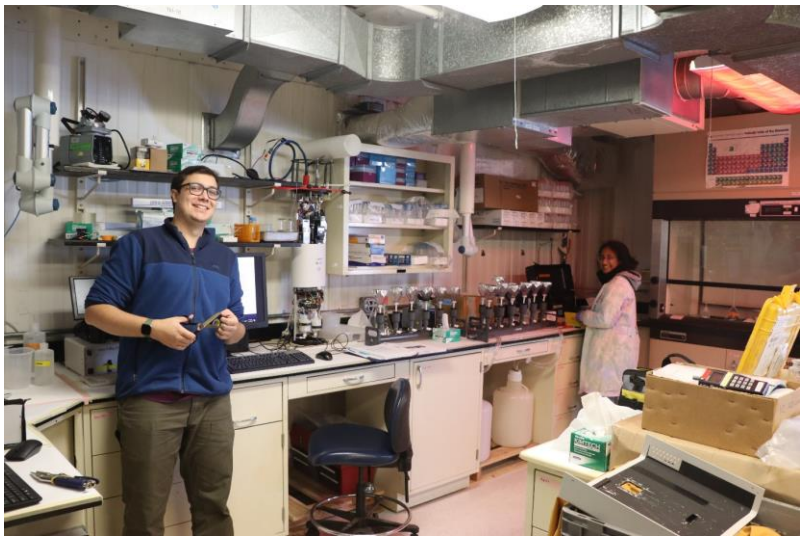

Figure 1- *Quintin (left) and Sneha (right) troubleshoot some instruments in Lab 10 as they set up their space for science. Image credit: Dr. David Fields*

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

Research at Palmer station has started up for the summer season and the Van Mooy lab group from the Department of Marine Chemistry and Geochemistry at WHOI could not be more thrilled. This summer we are looking forward to the field and lab work that will drive another season as part of the Long-Term Ecological Research (LTER) Project. The Palmer (PAL) Long Term Ecological Research (LTER) consists of three decades of research conducted on the Western side of the Antarctic Peninsula. The research at Palmer station helps to understand ecosystem changes in response to disturbance on a multiple temporal scales, including long-term climate warming, natural climate variability, and storms.

Lab 3 has been filled with equipment to support this summer season to help collect water samples from Station E. Setting up the labs has been the top priority to get ready for sampling twice a week throughout the season. The filter rigs have been prepared to collect samples for lipids, carbohydrates, and particulate organic carbon (POC). These samples will be collected from the Conductivity, Temperature, Depth (CTD) instrument, and the water will then be transferred to bottle or tubes for further analysis. The CTD will be also used to collect water samples to analyze the nutrients in the water column and microbial cell abundances by flow cytometry.

We would like to say “thank you” to all the Palmer personnel for their support on the station. We would also like to recognize the help and guidance from our Lab Supervisor Hannah James and the help from the Instrument Technician, Lance Roth. Finally, a thank you to all the support staff working hard to make sure science continues to happen for Palmer Station!

Figure 2- *Lab 3 prepared for water sampling on the filtration rigs. Image credit: Mackenzie Curtice*

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 Laurence M. Gould (Figure 3) supplied a large number of adult animals, which were successfully transferred to Palmer Station. This allowed us to immediately begin work on each of the three components (behavior of krill in response to horizontal flows and interactions with light and odor; krill responses to vertical flows and interactions; krill schooling behavior) during the reporting period. After roughly three weeks at station, both the horizontal flume and the annular (circular) flow devices have been assembled and used to acquire data.

Figure 3- *LMG support personnel help grantees Dr. David Fields collect krill. (left to right, Ken Block, David Fields, Anna McBee, Heather Jackson); krill being transferred from the LMG to the Palmer Station aquarium room by Palmer station science support staff. Image Credits- Marc Weissburg.*

The annular flume used to produce krill schools has been set up with the seven-camera recording system, flow and light levels calibrated, and schooling behavior elicited in groups of 700 krill. (Figure 4). 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 open ocean chlorophyll concentration of 2.5 µg chlorophyll L^{-1}. This produced coherent krill aggregations exhibiting coordinated movement, which will be investigated more fully when data is processed. 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 4- *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 5) has been used to obtain krill responses to flows from 0-6 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. Controlled lighting allows us to produce different intensities characteristic of krill at surface and at darkened conditions at depth, with spectral measurements suppling exact values.

Figure 5- *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 6), which allows us to parameterize krill behavioral responses to these conditions once data have been fully analyzed off-site. The reconstructed 3D paths (Figure 7) 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.

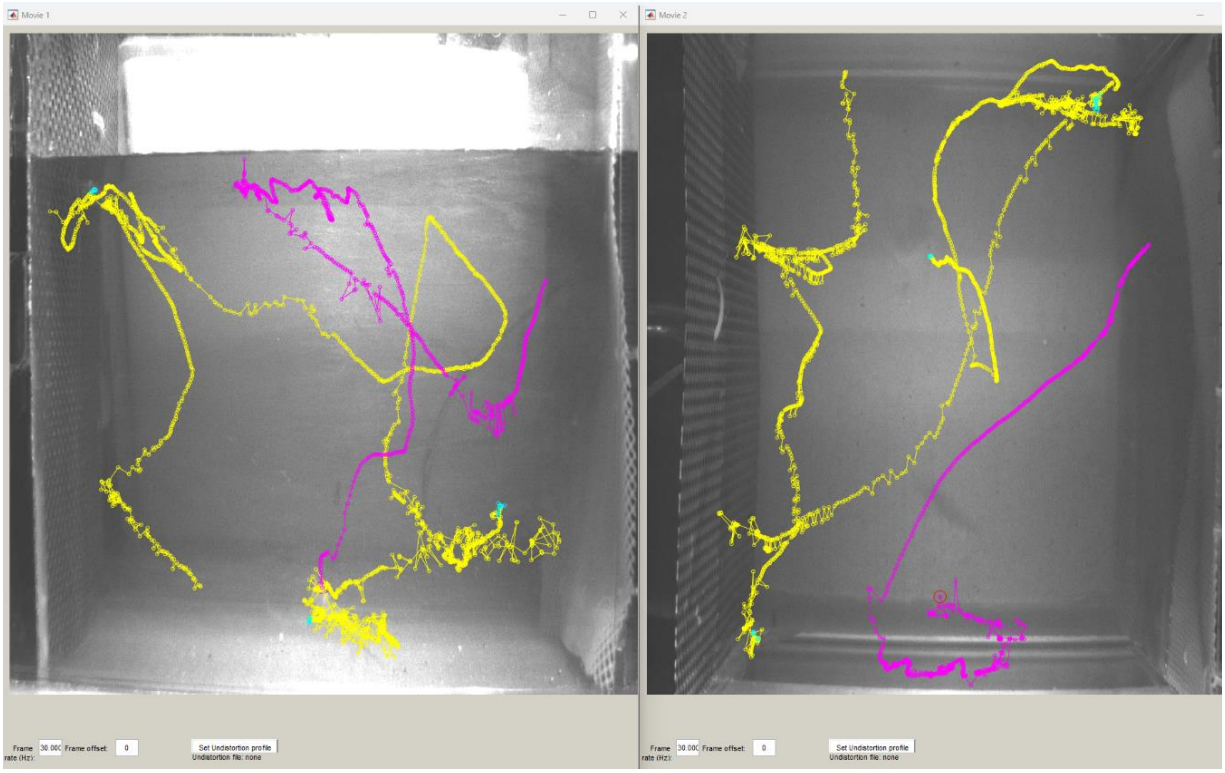

Figure 6- *Tracks of two krill (pink, yellow) as recorded in the flume at 3 cm s-1 flow and 5.5 ug chlorophyll L-1. The loopy nature of the tracks suggests area restricted search for food. The left panel show the x,z plane and the right panel the x,y plane*

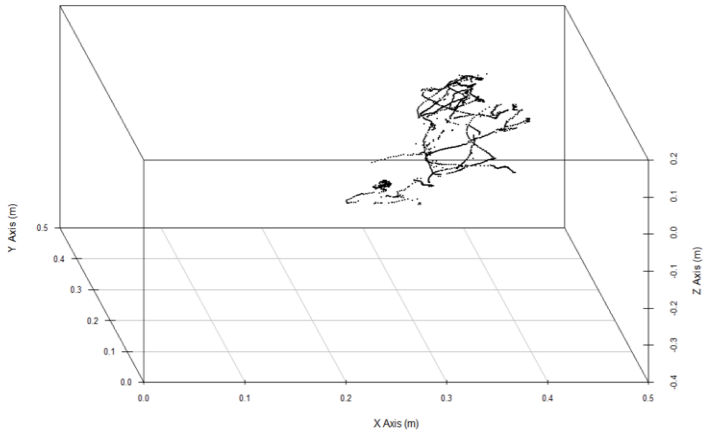

Figure 7- *3-Dimensional reconstructed track of a swimming krill (Track 1 from Figure 6)*

PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT
October 2022
Marissa Goerke

Sastrugi in the snowstake field near the seismic hut. *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.

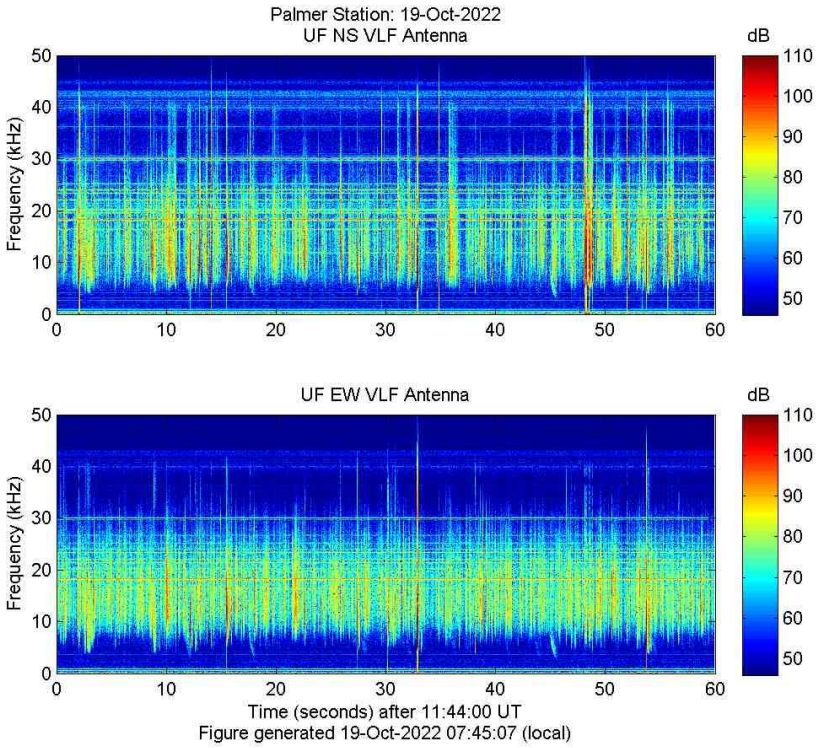

Figure 8- *Real-Time broadband VLF Spectrogram from Palmer Station, Antarctica*

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

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

A-111-P: SAMBA MAGNETOMETER

Andrew Gerrard, Principal Investigator, New Jersey Institute of Technology

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

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

The magnetometer was originally installed at Palmer in 2005, and a replacement installed in April of 2008. In 2017 the project was taken over by Andrew Gerrard. On February 27th, 2017 the USAP IT blocked all northbound VPN traffic under a larger umbrella of blocking all

northbound encrypted-tunnel traffic. Since that time there has been much discussion, but the magnetometer is still considered a security vulnerability. The Research Associate has been working with the home institution at the University of California, Los Angeles to resolve this issue. As of September 30th, 2020 at 7:45am local time, the magnetometer was removed from the network. The instrumentation and computer are still operational. Data will continue to be collected and stored locally. The RA is working with the IT department to send out the data to UCLA when requested. More information can be found at: http://magnetometers.bc.edu/index.php/palmer.

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

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

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

The 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.

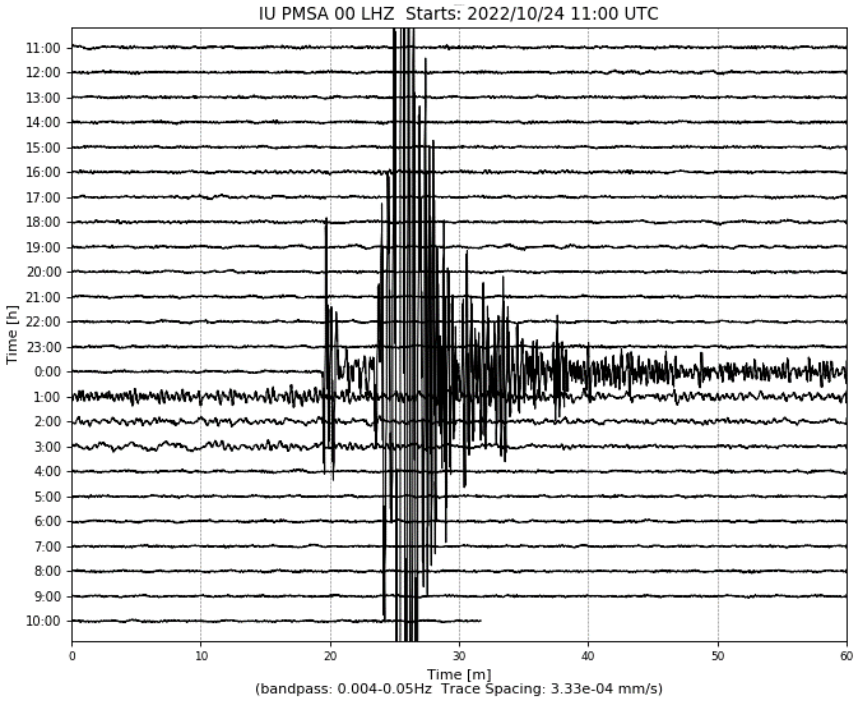

Figure 9- *An earthquakes occurring on October 23, 2022 in the South Sandwich Islands Region*

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.

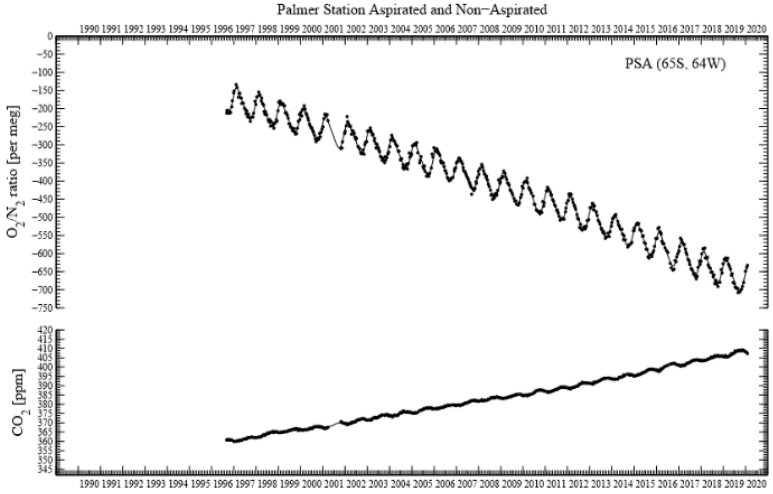

Figure 10- *Historical plot of* $\boldsymbol{O_2/N_2}$ *ratio per meg and* $\boldsymbol{CO_2}$ *ppm updated on July 29, 2020.*

Air samples were collected on October 4 and October 14. 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 October 3, October 10, October 19, October 24, and October 31 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/.

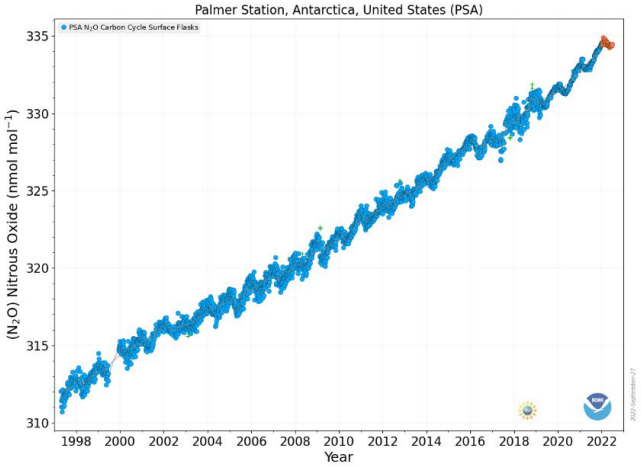

Figure 11- *Nitrous Oxide (N_2O) levels at Palmer Station dating back to 1997. Orange dots are preliminary data.*

Halocarbons and other Atmospheric Trace Species (HATS) samples were collected on October 11 and October 25 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.

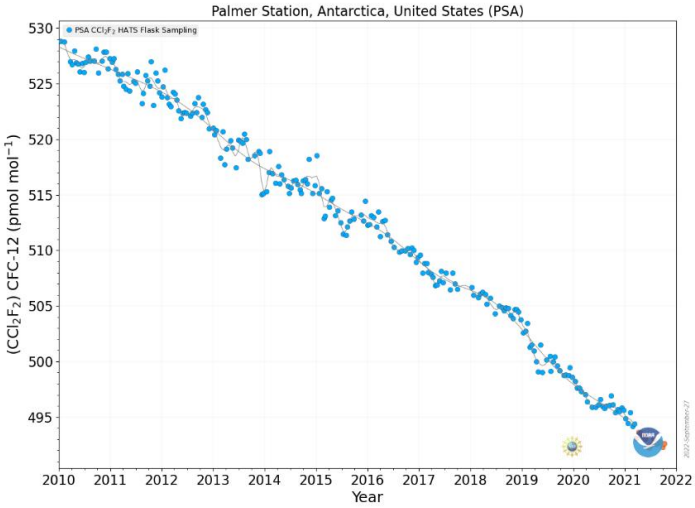

Figure 12- *CFC-12 (CCl_2F_2) levels at Palmer Station dating back to 1998, one of the Halocarbon and Trace Gases measured at Palmer Station.*

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

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

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

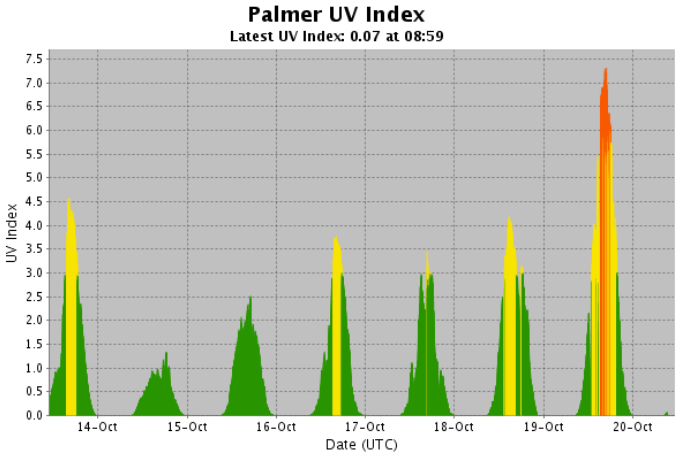

Figure 13- *UV index generated from the GUV-511 radiometer in real time.*

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 October 10 and October 22 without issues. An issue with the HRAD required a full system reboot to clear on October 16. The highest UV levels for the season so far were reached on October 20 at 7.4 on the UV index.

Figure 14- *It's not just snow that lands on the sensors. Image credit: Marissa Goerke*

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.

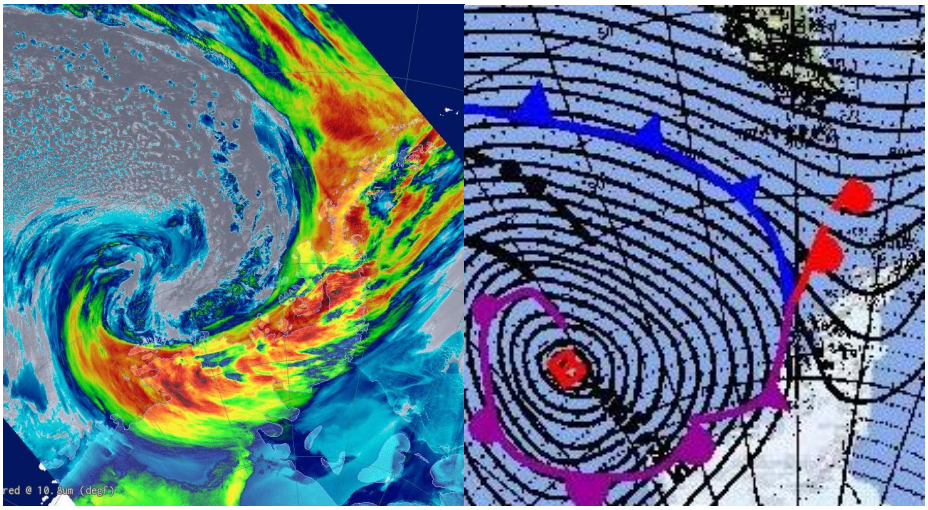

Figure 15 *METOP-3 October-17 satellite pass (left) explained by the Chilean Navy Meteorological Map (right).*

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.

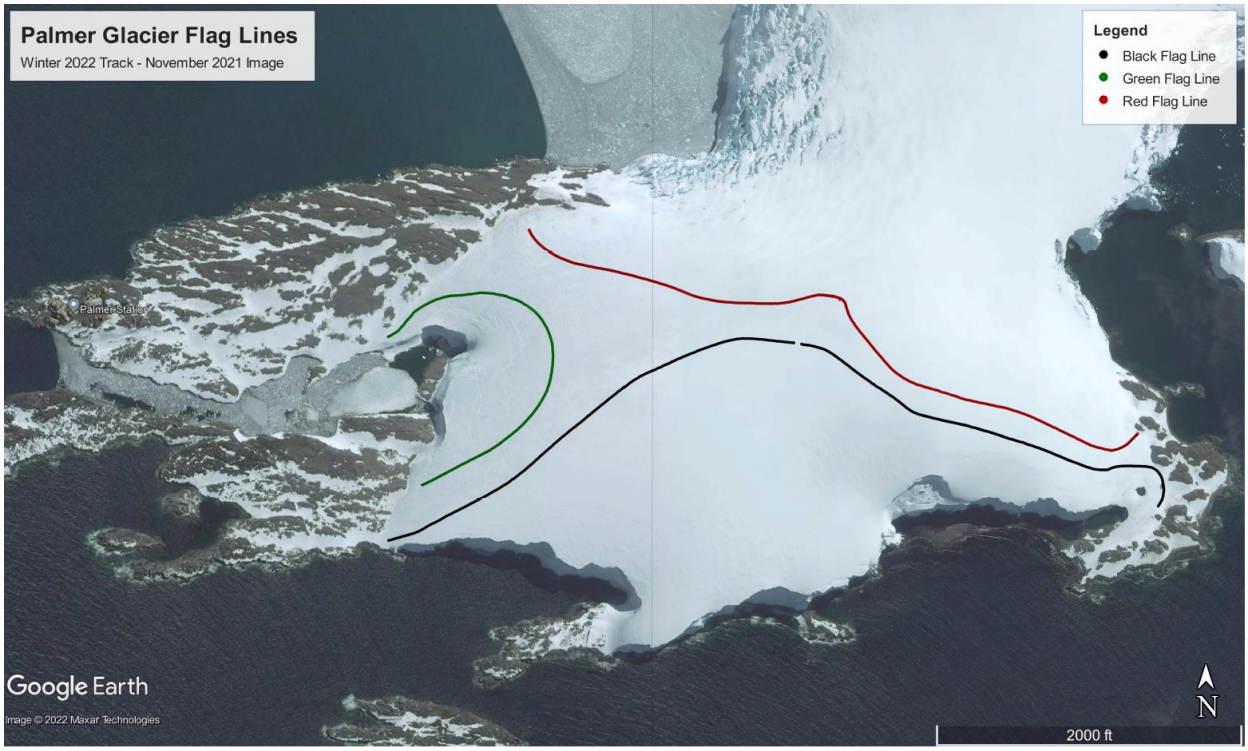

Figure 16- *Results of glacier flag line survey*

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/.

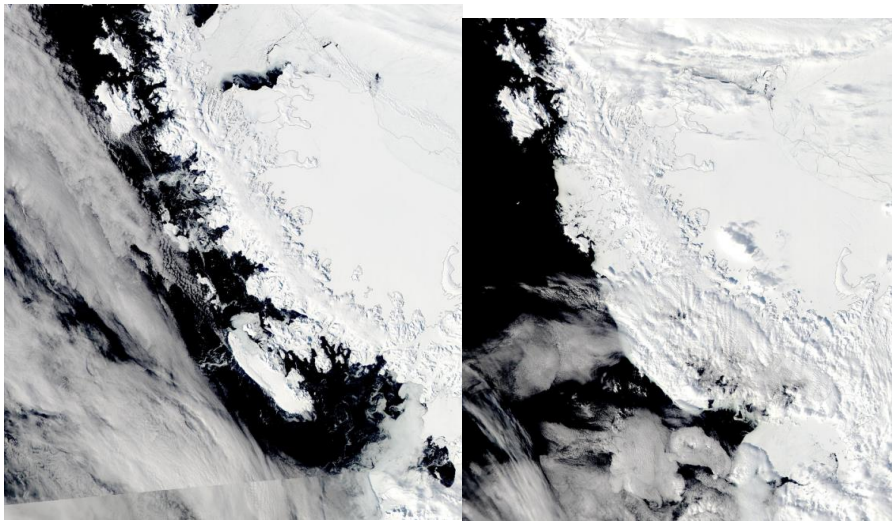

Figure 17- *Sea ice concentration south of Anvers Island, October 2021 vs. October 2022. Source: EOSDIS Worldview*

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 Palmer Snow Accumulation measurement field was moved away from the influence of the local station area into a gulley in the backyard in 2016. The field of stakes is a series of meter sticks sleeved over five rebar anchors spanning a south facing side, a north facing side, and bottom of the gulley. These data come from the average daily accumulation as measured at each of the five snow stakes. As seen in Figure 18, this snow year was slow to accumulate, most likely due to warm temperatures and at times, rain. October was much closer to average temperature and cooler on average than the last couple months. Palmer started October with an average snow pack, and a total of 57 cm (22 inches) of snow fell during the month. Over half of that accumulation did not melt or blow away. This amount of precipitation for October was not unprecedented, but has not occurred in six years.

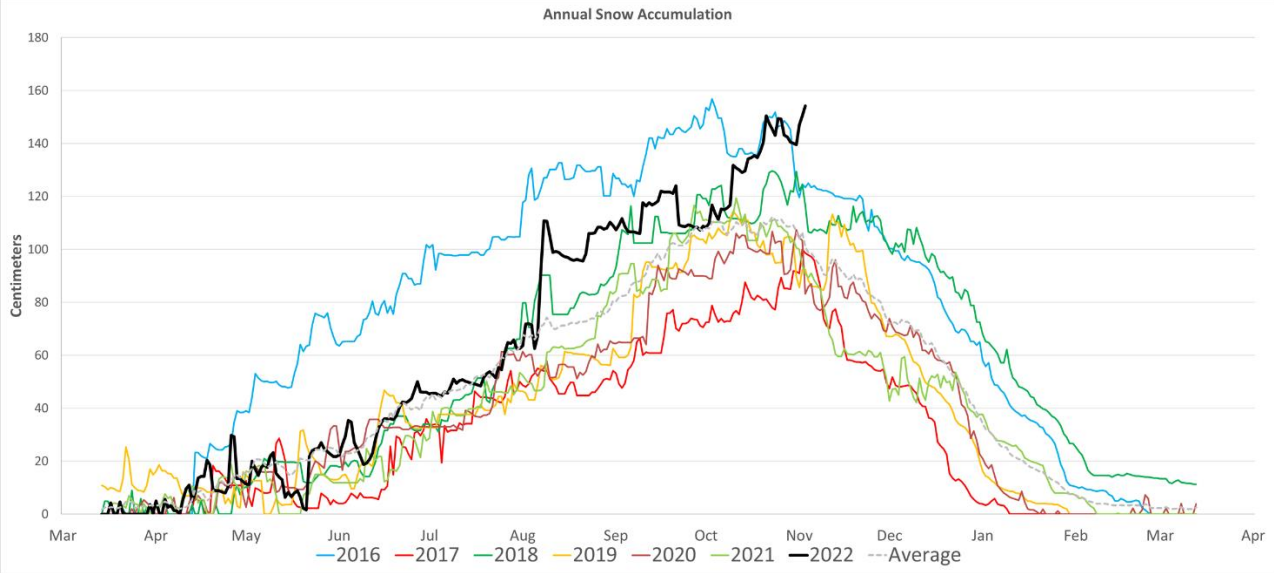

Figure 18- *Snow accumulation dating back to 2016. The black line represents the current 2022 season.*

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 main temperature sensor failed on October 17 and was replaced on October 18. Erroneous data was removed from archive. A loose cable resulted in an outage in the early hours of October 30. One minute weather data is archived on the AMRC website: http://amrc.ssec.wisc.edu/data/ftp/pub/palmer/.

Palmer Monthly Met summary for October, 2022

Temperature
Average: -1.6°C / 29.1°F
Maximum: 4.3°C / 39.74°F on 5 Oct 08:25
Minimum: -5.8°C / 21.56°F on 16 Oct 11:07
Air Pressure
Average: 973.6 mb
Maximum: 1001.4 mb on 3 Oct 12:07
Minimum: 929.3 mb on 9 Oct 11:33
Wind
Average: 15.3 knots / 17.6 mph
Peak (5 Sec Gust): 59 knots / 68 mph on 18 Oct 19:51 from NNE (026 deg)
Prevailing Direction for Month: NNW
Surface
Total Rainfall: 55.1 mm / 2.17 in
Total Snowfall: 57 cm / 22.2 in
Greatest Depth at Snow Stake: 150.4 cm / 58.7 in
WMO Sea Ice Observation: 1-5 bergs, bergy bits, growlers, and brash ice
Average Sea Surface Temperature: -1.05°C / 30.1°F