PALMER STATION MONTHLY SCIENCE REPORT

December 2024

Gentoo and Chinstrap penguins share a bergy bit floating through the local boating area. Many ice bergs and bergy bits remain around station. It is always a treat to see the local wildlife hauled out on them!
Image credit: Dr. Natasja van Gestel

NEWS FROM THE LAB

Hannah James, Summer Lab Supervisor

December was an incredibly productive month on the water, throughout our remote islands, downstairs in BioLab, and up the hill at Terra Lab. With the long daylight hours and hardworking onsite personnel, there are plenty of updates to read for each of our science groups below. Some quick highlights for each of the deployed groups include B-086-P (van Gestel) setting up all of their open top chambers to start the seasonal warming experiments. The C-013-P (Cimino) birding team was on the water nearly every day throughout the month doing annual surveys and preparing for their busy tagging season. The C-013-P (Cimino) group also successfully turned over the C-024-P (Friedlaender) acoustic mooring at Station H. Meanwhile on R/V *HADAR*, C-019-P (Schofield) and C-020-P (Steinberg) groups were busy collecting water at Station E and processing phytoplankton and zooplankton galore back in the labs. When the weather and sea state allowed, the Adélie and Gentoo transects were completed.

This season we are able to welcome back cruise ships for on-shore tours around station. This includes time in the galley to view some more recent scientific posters and talk with grantees and ASC staff. We welcomed visitors from three different ships for these on-shore visits, and also conducted our first off-shore visits since before the pandemic began. During most of these visits, the station manager (currently Ken Keenan, but Bob Farrell will soon return to finish out the summer season) and I head out to the ship to give a presentation where we introduce the passengers to the United States Antarctic Program. Ken highlights the international cooperation that occurs throughout the continent, as well as the interagency work the United States depends on for the logistics for getting people and supplies to and from the continent, as well as the different branches of government that directly fund grants to conduct scientific research. Ken then introduces the US bases around the continent, stating the basic goals for science and infrastructure at both McMurdo and South Pole stations. I present the second half of the presentation, where I give a summary of the science groups that are currently on site at Palmer Station as well as give an overview of the Terra Lab science that is supported year round.

We gave station tours to passengers of the *Argus, Le Lyrial*, and *World Navigator.* A group of Palmer Station residents spent the afternoon on the M/V *Oosterdam* for two back-to-back offshore lectures with a chance for Q&A at the end, followed by mingling with passengers through dinner and the evening.

Our weekly Science Tuesday lecture series continued through December. This month both C-020-P (Steinberg) team members presented. Meredith gave an excellent overview of the Palmer LTER program as a whole, including the LTER cruise, and then honed in on her focus on the importance of the zooplankton local to our community. The following week Isabelle presented on her focus of study: Harmful Algal Blooms and the work she has done in Alaska. Matt Gosselin, one of our small boat captains, hosted a hands-on workshop and tutorial on Yamaha engines that power our small boats on station. Thank you to each of these Science Tuesday presenters! Even with the cruise ship visits, holiday time off, and occasional bad-weather day, Palmer Station had an incredibly productive December. I'll let each group speak for themselves below.

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

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

Personnel on station: Dr. Natasja van Gestel and Tiego Ferreira de la Vega

Science

Our experimental design encompasses forty plots in total, with ten plots at each of the four sites. We successfully deployed the open-top chambers in half the plots at all the sites (the other half serve as unwarmed controls). These chambers are made of transparent fiberglass. The material has high transmittance for visible light, and low transmittance in the infrared wavelengths. This enables the air inside to warm up (see Figure 1).

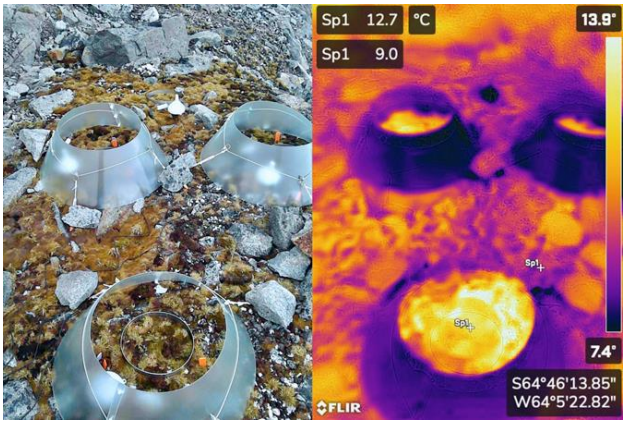

Figure 1- Open-top chambers increase air temperatures inside the plots. *Image credits: Natasja van Gestel.*

The warming treatment started in mid-December (December 15 and 16) for all sites, except for the site closest to the glacier, which was still covered beneath snow and ice. On December 21, this remaining site was finally free of snow and ice and we were able to deploy the chambers.

Meanwhile, Tiego was trained on how to use the LI-6800 gas exchange machine that measures carbon fluxes. In order to calculate the CO2 concentration on a per volume basis for each plot, we measured the average height of the soil collars that are semi-permanently placed within each plot.

Lastly, at each site visit, we recorded spot measurements of average soil temperature on the soil surface inside warmed and control plots. Data loggers and attached sensors measure the temperatures from the upper soil (0-5 cm) every 20 minutes throughout the summer.

Additionally, for microclimate data, the iButtons inside a solar radiation shield measure the relative humidity and temperature about 10 cm above the soil surface every 30 minutes.

Outreach/Broader Impacts
We had two cruise ships visiting this month: The M/V *World Navigator* visited us on December 20th and the M/V *Oosterdam* on December 27th. Both times I engaged with the passengers to discuss research at Palmer Station, and was a member of a Q&A panel at the end of the offshore lecture given by Palmer Station Manager Ken Keenan and Lab Manager Hannah James.

Online, my Antarctic blog (https://www.nvangestel.com/antarctica) grew to 3,116 users (up from 2,839 last month), from 63 countries. Lastly, my Instagram @AntarcticResearchAdventures (https://www.instagram.com/antarcticresearchadventures/) has now grown to 350 followers (up from 317 at end of November).

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

In December, conditions enabled boat-based fieldwork on 27 days. While an attempt was made to survey the Rosenthal Islands, adverse sea conditions northwest of Cape Monaco hindered the success of this mission.

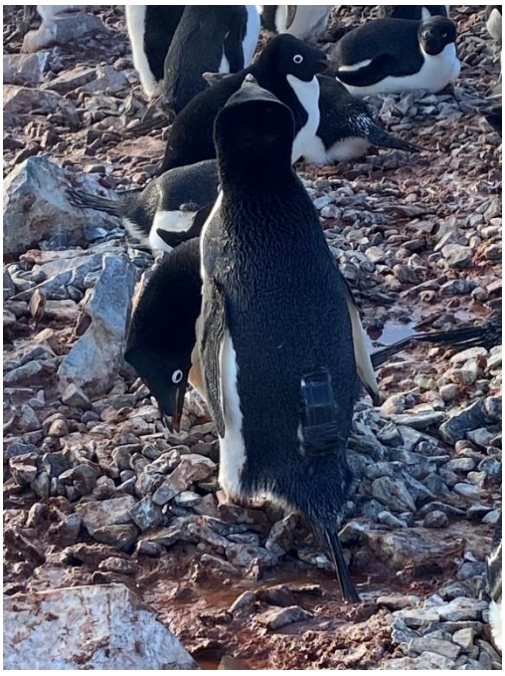

Figure 2- A Cell Track tag deployed on an Adélie penguin. Image *Credit: Ricky Robbins*

Daily monitoring of nesting Adélie penguins continued on Humble and Torgersen Islands, alongside regular censuses of all local Adélie colonies. The team also completed several trips to Dream Island for Adélie and Chinstrap penguin counts, as well as to Biscoe Point for Adélie and Gentoo penguin counts. Additional surveys of Adélie, Gentoo, and Chinstrap penguins were conducted in the Joubin Islands.

Preparations for the Humble Island Adélie penguin radio transmitter project progressed. Equipment was installed on the island, and remote data collection and transfer systems were successfully tested. Subsequently, 14 radio tags were deployed to monitor the presence and absence of penguins at their nesting sites on Humble Island.

We also prepared for the deployment of satellite transmitters and dive depth recorders on Adélie and Gentoo penguins. The tagging of Adélie penguins on Torgersen Island and Gentoo penguins at Point 8 was initiated. Additionally, 14 Cell Track tags were deployed on Adélie penguins across various locations, including Biscoe, Christine, Humble, Torgersen, and Dream Islands. These tags broadcast dive and location data and are deployed for longer than our standard GPS tags, remaining on the birds for several months.

Skua-related work continued throughout the month, including the monitoring of Brown Skua nests on local islands, Dream Island, and Biscoe Island. The South Polar Skua mark-recapture and breeding monitoring study at Shortcut Island also progressed with nest initiation checks and band recordings. Our census of the Blue-eyed Shag colony on Cormorant Island continued, with the first chicks of the season observed in early December. Additionally, a gull survey was completed at all local kelp gull colonies.

Figure 3- A Brown Skua with chick at Biscoe. *Image credit: Megan Roberts*

An all-island census of Giant Petrel nests was initiated, with breeding pairs identified and unbanded birds banded. Tracking of Giant Petrel foraging began with the deployment of satellite transmitters on Stepping Stones, Shortcut, Elephant Rocks, and Humble Islands. We also recovered several of our over-winter tags from Giant Petrels at Shortcut Island.

In early December our team swapped an acoustic mooring for the C-024-P (Friendlaender) group near Janus Island. This mooring is used to passively monitor whale activity in the area.

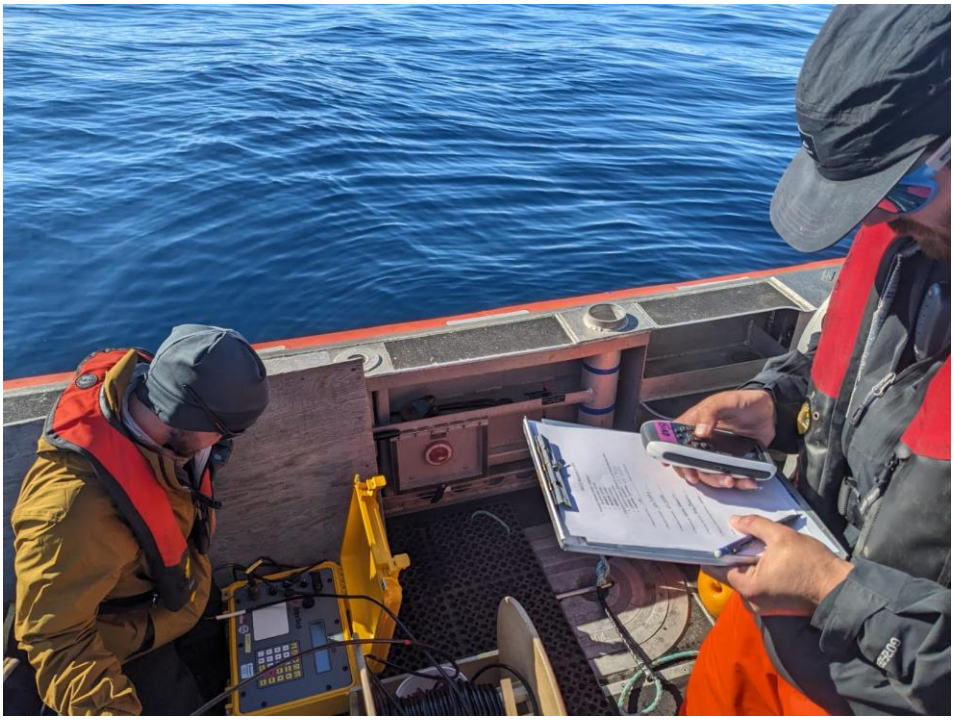

Figure 4- Members of C-013-P (Cimino) team recovering the C-024-P (Friedlaender) mooring. *Image credit: Hannah James*

Finally, we would like to extend our sincere gratitude to Natasja van Gestel and Ken Keenan for their invaluable support and expertise in planning and execution of our attempt at the Rosenthal Islands.

C-019-P: Palmer, Antarctica Long Term Ecological Research (PAL-LTER): Ecological Response to "Press-Pulse" Disturbances Along a Rapidly Changing West Antarctic Peninsula

Dr. Oscar Schofield, Principal Investigator, Rutgers University, Institute for Earth, Ocean, and Atmospheric Sciences, Department of Marine and Coastal Sciences
Personnel on Station: Abby Tomita and Charlotte Bramich

Science is in full swing at Palmer Station! December has been full of Station E sampling days, cruise ship visits, and holiday festivities. Station E sampling for the C-019-P (Schofield) group consists of a Compact Propulsion Option for Profiling Systems (C-PrOPS) deployment, followed by water sample collection at various depths using a CTD Rosette. The C-PrOPS is used to measure light attenuation and photosynthetically active radiation throughout the water column. The ROV is driven away from the boat to avoid any shadow before freefalling down to 65 meters, collecting measurements on the downcast. Once the C-PrOPS is back on board, the CTD Rosette is prepped for deployment. Equipped with six niskin bottles, the rosette is sent to depth for water collection and is followed with two Go-Flo bottles for surface collection. The CTD Rosette hosts a suite of instruments which measure parameters such as salinity, temperature, and fluorescence. Once all of the necessary water is collected, the team heads back to station for post-sample processing.

Figure 5- From left to right: Ken Keenan, Danny Tropper, Abby Tomita, and Charlotte Bramich test running the C-PrOPS from the floating dock *Image credit: Natasja van Gestel*

The C-019- P (Schofield) group successfully started and completed five C14 primary production experiments in December. These experiments are performed to understand the rate at which photosynthesis is carried out in phytoplankton from various depths. Water samples are spiked with sodium bicarbonate that contains a radioisotope of carbon and then placed into incubation bottles. The bottles are covered with mesh to simulate the amount of light from each sample's respective depth. The isotope acts as a tracer that can be measured to understand the uptake of nutrients into their cells over a given time period.

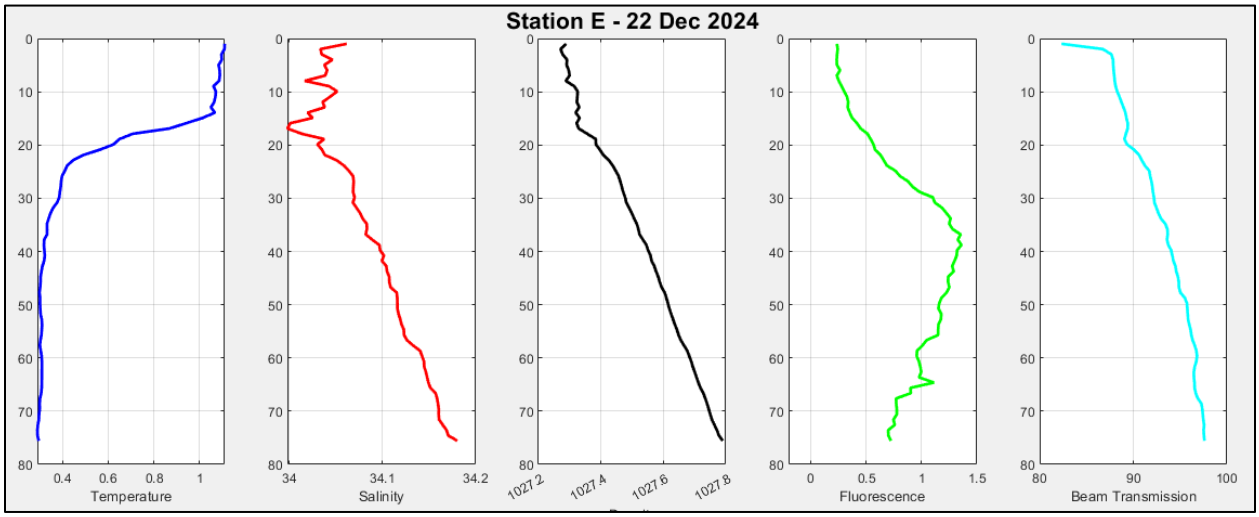

Figure 6- Station E data from the CTD Rosette on December 22, 2024.

A few cruise ships visited Palmer Station in December, which gave Abby, Charlotte, and other grantees ample opportunity to assist with tours around station and engage with visitors who were eager to learn about what science is happening on Anvers Island. Abby got the unique opportunity to go aboard the Holland America M/V *OOSTERDAM* cruise ship to represent the phytoplankton component of the LTER dataset. She was part of a Q&A panel after a presentation given by the Palmer Station Manager and Lab Manager, and then interacted with guests around

the cruise ship for the remainder of the afternoon. The guests were very excited to catch a glimpse into the world of Antarctic research at Palmer Station.

As folks on station ring in the New Year, the team has big plans to deploy the Rutgers University Slocum AUV glider. Time has passed quickly and while Charlotte is bummed to be gearing up to head north, the team is looking forward to welcoming PhD student Mya Sharpe to station and continuing science operations for the C-019-P (Schofield) group.

C-020-P: PALMER, ANTARCTICA LONG TERM ECOLOGICAL RESEARCH (PAL-LTER): ECOLOGICAL RESPONSE TO "PRESS-PULSE" DISTURBANCES ALONG A RAPIDLY CHANGING WEST ANTARCTIC PENINSULA
Dr. Deborah Steinberg, Principle Investigator, Virginia Institute of Marine Science, William & Mary's Batten School, Section for Coastal & Ocean Processes
Personnel currently on station: Meredith Nolan, Isabelle Castro

Another month is in the books for the C-020-P (Steinberg) group! This month we began our normal sampling schedule, which includes net tows at Station E on Tuesday and Friday. We have also been conducting acoustic transects in penguin foraging grounds as weather allows in collaboration with the C-019-P (Schofield) and C-013-P (Cimino) groups.

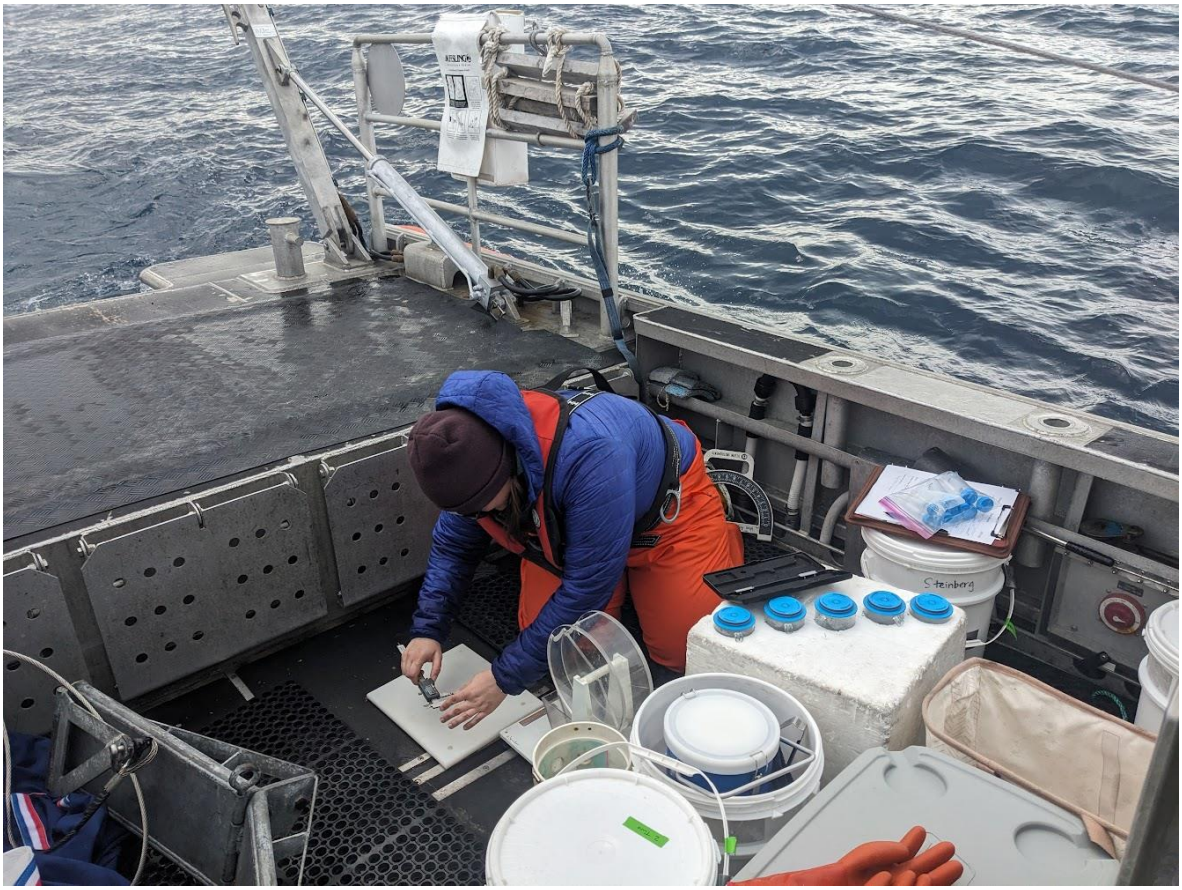

Figure 7- Meredith measures a salp onboard R/V HADAR. *Image credit: Hannah James*

Each time we sample at Station E, we deploy our 1-m^2 frame metro net and 1-m ring net twice each, for a total of four net tows. The first two metro net tows and the first ring net are used for

species identification and counts. The second ring net is split in half using a Folsom plankton splitter onboard R/V *HADAR*. Each half is filtered into different size classes (5000, 2000, 1000, 500, and 200 microns) to see how biomass and gut fluorescence differ between the size classes. We saw a distinct shift in the community composition of net tows from *Euphausia superba* (Antarctic krill) in early December to *Salpa thompsoni* (salps) in late December. Copepods and chaetognaths (arrow worms) have been present and abundant throughout the month. In one tow, we caught a large Beroe ctenophore, otherwise known as a comb jelly.

Figure 8- Left: *Salpa thompsoni* individuals laid out for measurement. *Image credit – Isabelle Castro.* Right: *Beroe* ctenophore in a large tripour. *Image credit – Meredith Nolan.*

In addition to our regular sampling, we were able to conduct one more warming experiment on juvenile krill caught in October aboard the RVIB *NATHANIEL B. PALMER* in Gerlache Strait. Next, we would like to conduct these experiments on krill caught near Palmer Station. We were able to go on one "krill hunt," using the EK80 aboard R/V *HADAR* to do targeted net tows for Antarctic krill. Unfortunately, we are having issues with the krill surviving once they are transferred into the aquarium tanks. We plan to conduct another "krill hunt" in the upcoming weeks using what we learned from the previous one. We are excited to continue our weekly sampling and see the second half of the Steinberg team in the middle of January!

PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT
December 2024
Ben Rosen-Filardo

Acrux headed back from the Gosslers, December 5th, 2024. *Image credit: Ben Rosen-Filardo*

A-111-P: THE NEXT GENERATION OF GEOSPACE RESEARCH FACILITIES AT PALMER STATION

Dr. Hyomin Kim, Principal Investigator, New Jersey Institute of Technology; Newark, NJ

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.

The ELF/VLF radio wave observations at Palmer Station contributes to the wider network of experiments studying high-latitude geospace variables. Together with South Pole and McMurdo, these staffed U.S. Antarctic geophysical stations measures the interactions between Earth's upper atmosphere, the magnetosphere, and solar wind. In 2026, this imperative network will be managed by the NJIT-Polar Engineering Development Center (PEDC).

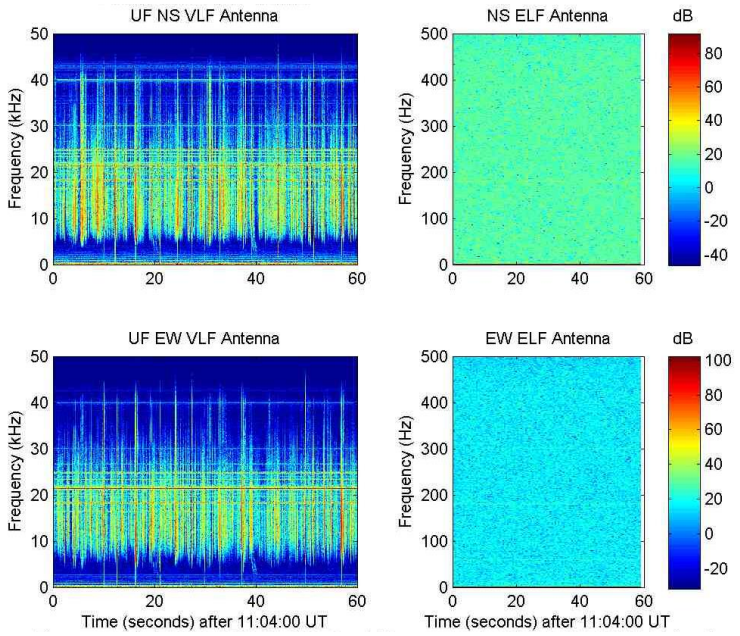

Figure 9. Real-Time broadband VLF and ELF Spectrogram from Palmer Station, Antarctica.

The VLF/ELF radios have been turned on, though are not logging data. The bi-weekly antenna inspections continued as weather allowed. The VLF PC was downgraded to Windows 10 but the DAQ is not yet up and running. A new computer will be arriving in January, 2025.

When online, 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

Dr. Hyomin Kim, Principal Investigator, New Jersey Institute of Technology; Newark, NJ

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. In 2024 the project was taken over by Dr. Hyomin Kim.

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. A new Raspberry Pi system was installed in 2023. The system has been down since December 8th due to ongoing issues with the data acquisition software. More information can be found at: http://magnetometers.bc.edu/index.php/palmer.

G-090-P: GLOBAL SEISMOGRAPH NETWORK (GSN) SITE AT PALMER STATION.
Dr. David Wilson, Supervisor Research Geophysicist, USGS Earthquake Hazards Program, Albuquerque, NM

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.

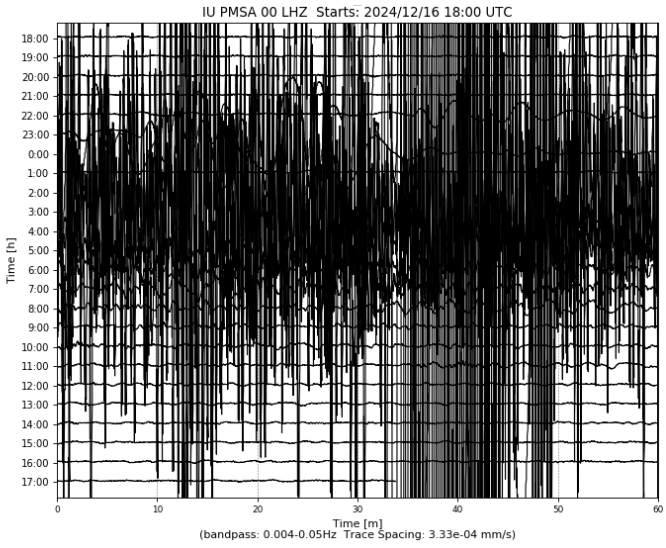

Figure 10- A December 17th magnitude 7.3 earthquake in Vanuatu, as recorded from the Palmer seismic station. The earthquake killed 12 people and triggered small tsunami waves.

The system performed normally during 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.

Drs. Vanda Grubisic and Ralph Keeling, Principal Investigators, National Oceanic and Atmospheric Administration /Global Monitoring Laboratory; Boulder, CO and Scripps Institution of Oceanography; La Jolla, CA

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.

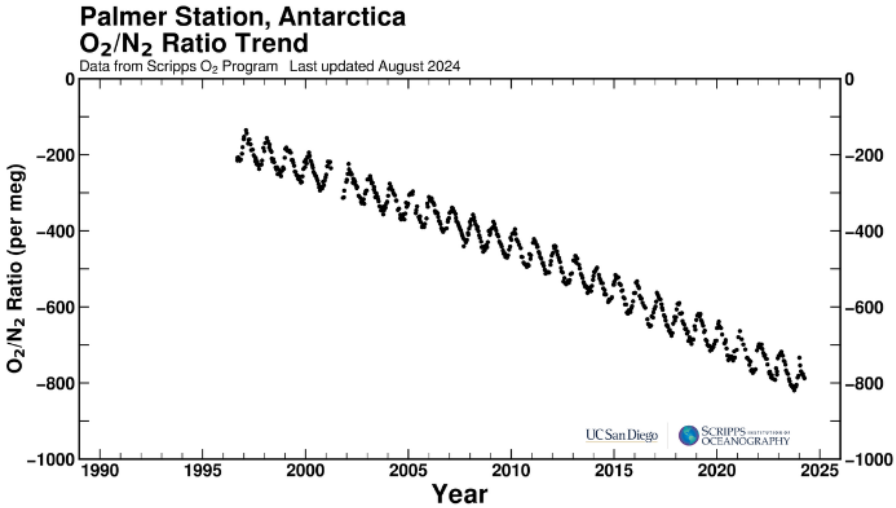

Figure 11- Historical plot of $\mathbf{O_2/N_2}$ ratio per meg and $\mathbf{CO_2}$ ppm, updated August 2024.

Air samples were collected on December 10th and 22nd. 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/graphics-gallery/o2n2-graphics/psa.html.

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

Dr. Vanda Grubisic, Principal Investigator, 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 December 1st, 6th, 12th, 17th, 23rd, and 30th during favorable wind conditions. More information and data for the Carbon Cycle group can be found at: https://gml.noaa.gov/ccgg/.

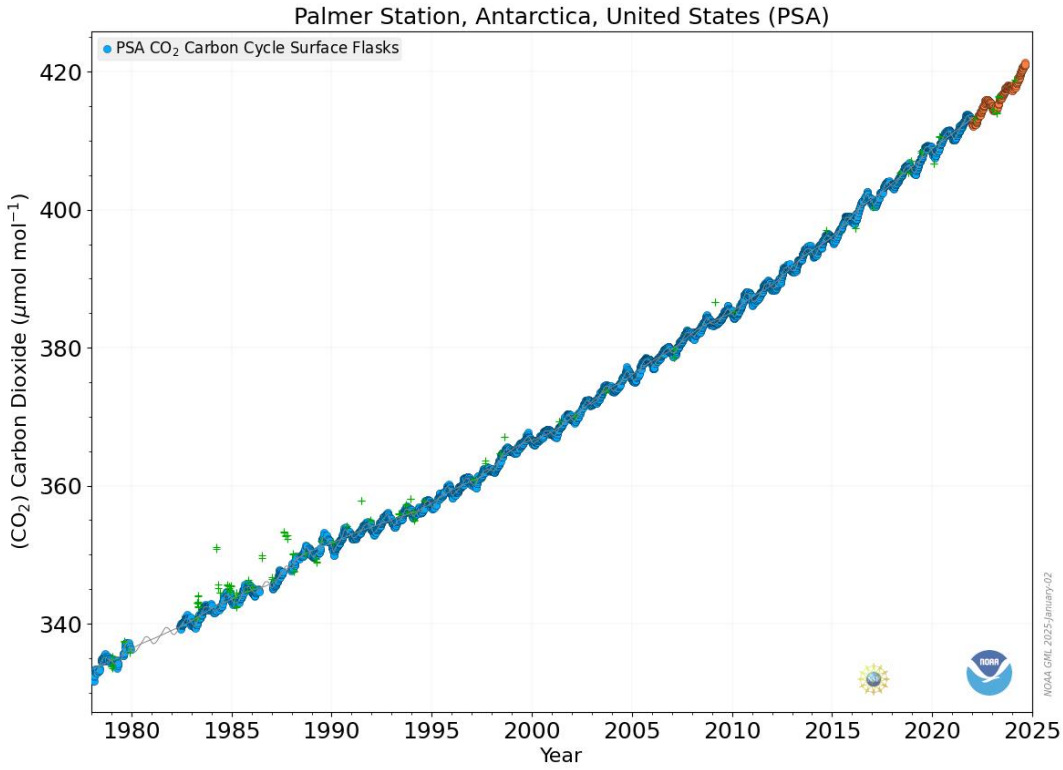

Figure 12- Carbon Dioxide (CO_2) levels at Palmer Station dating back to 1978. Orange dots are preliminary data and green pluses are poorly mixed air masses, which should not indicate background conditions.

HATS samples were collected on December 10th and 24th 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/

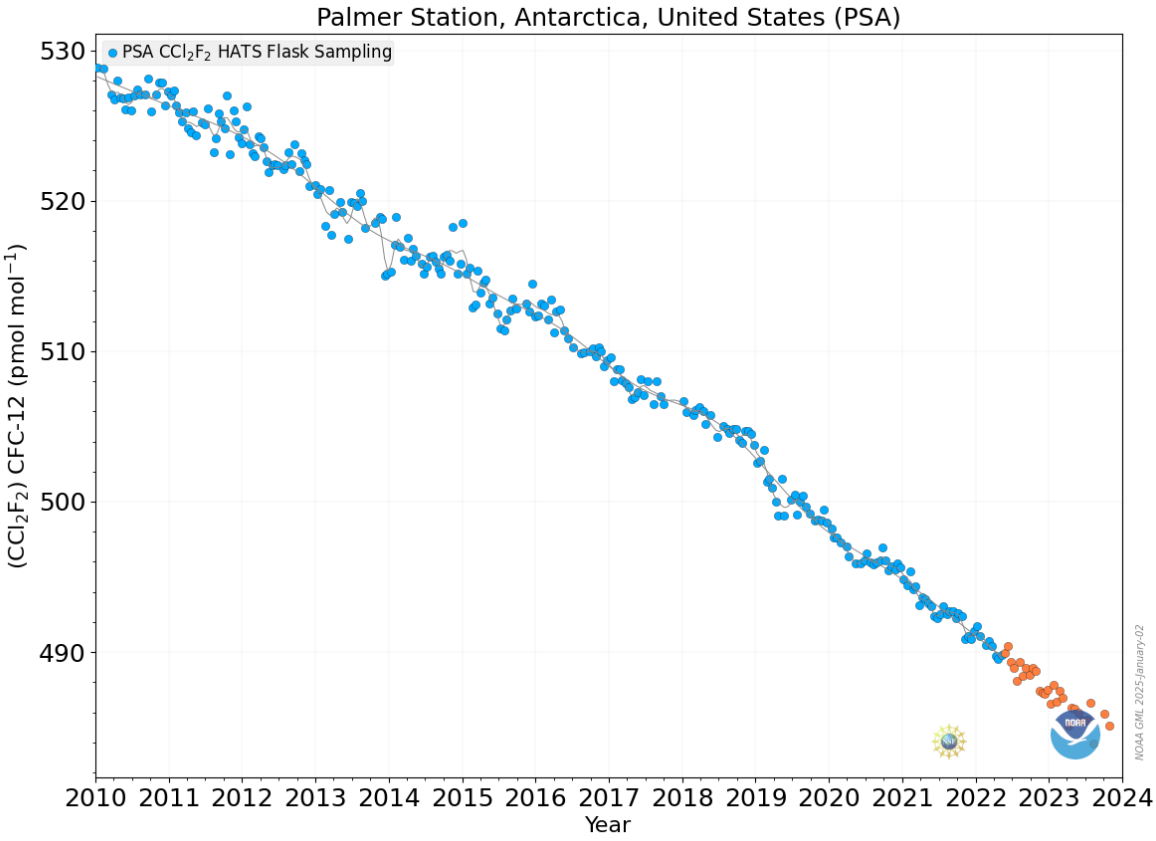

Figure 13- CFC-12 (CCl_2F_2) levels dating back to 2010, one of the Halocarbon and Trace Gases measured at Palmer Station. Orange dots are preliminary data.

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

Dr. 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.

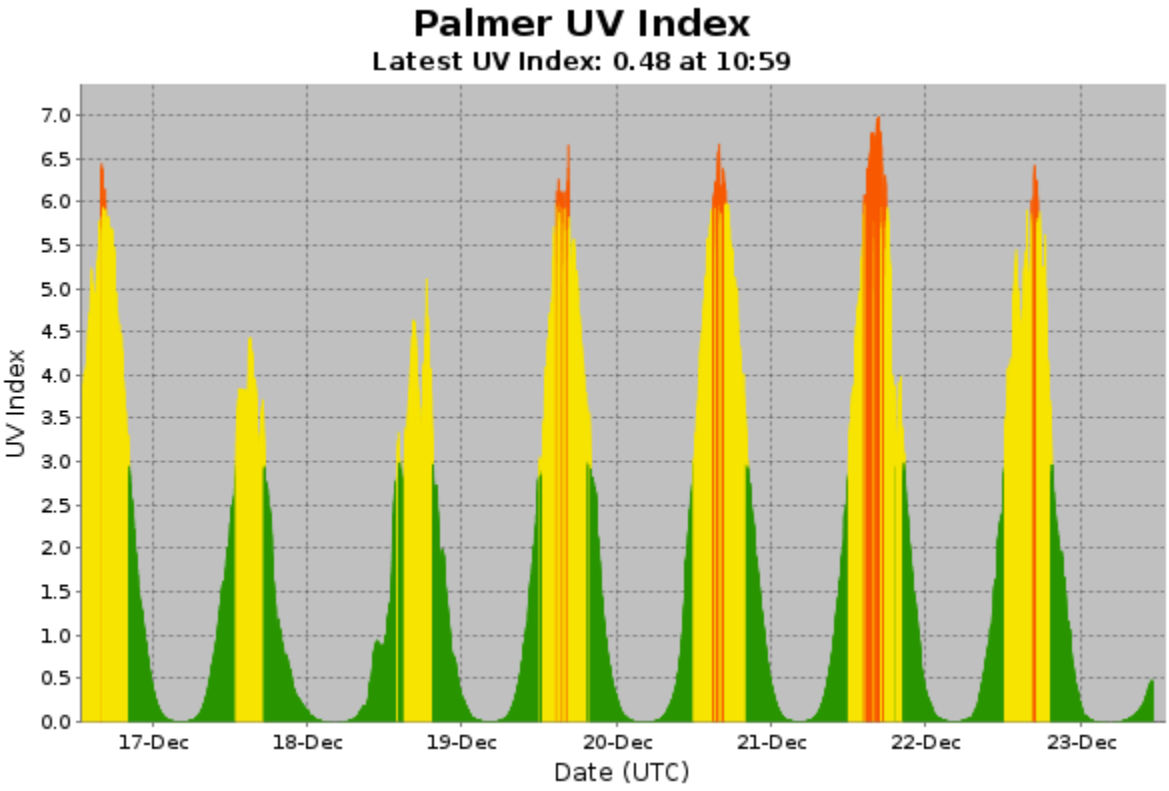

Figure 14- UV index generated from the GUV-511 radiometer in real time.

The log was filled out and collectors were cleaned on a daily basis. Level checks were performed once a week to confirm that the instrumentation was within +/- 0.2 degrees. The weekly log was sent out each Monday, and SUV-100 Absolute Scans were performed on December 3rd, 17th, and 31st without issues. The connector on the TUVR is broken, and the instrument has been intermittently reporting since November 5th.

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.

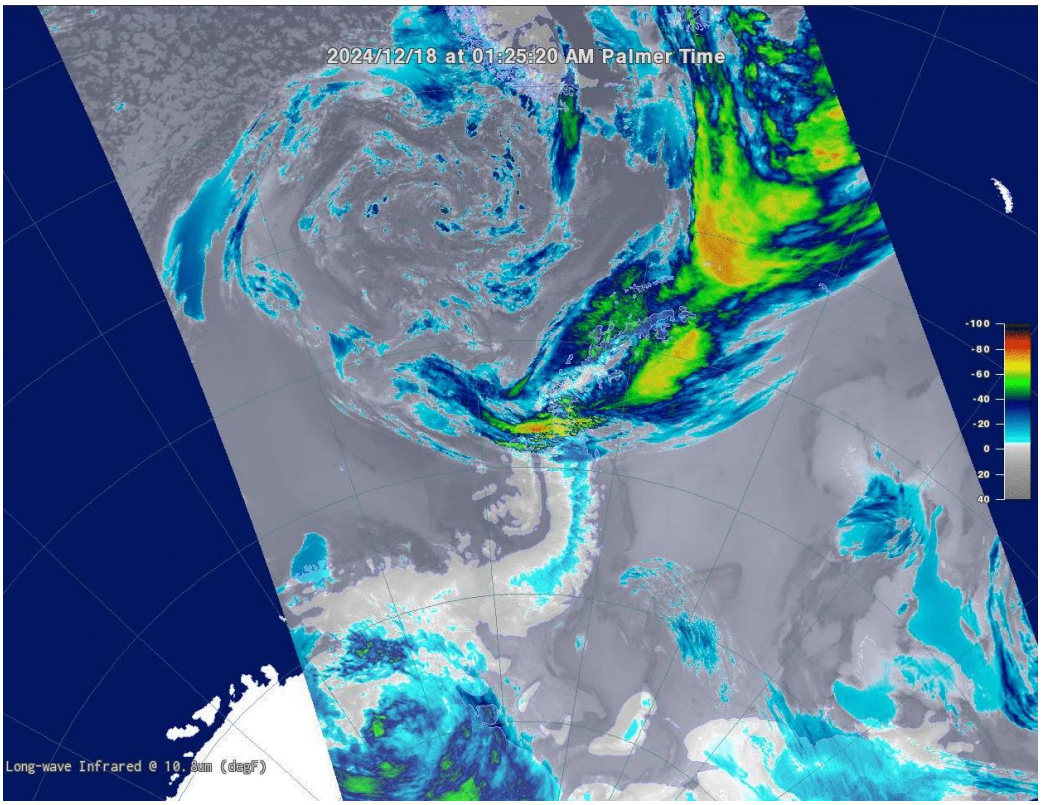

Figure 15- NOAA-18 December 18th satellite pass.

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, EarthScope Consortium; Washington, DC and Socorro, NM

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 EarthScope. 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.

Due to potential issues with the antenna and/or splitter, the Trimble receiver is currently disconnected. Troubleshooting is ongoing. For more information, visit: https://www.unavco.org/polar-services/forward-fielded-instruments/palmer-station/

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 of 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 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 amount of filter material was checked as needed. Daily filters were processed on December 10th, 17th, and 21st. The monthly log was sent on time. Preparations are being made for the grantee site visit in January. 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 in June 2022.

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.

Strong, warm, easterly winds this month blew the last of the sea ice out of Hero Inlet. However, many large bergs remain in the boating area.

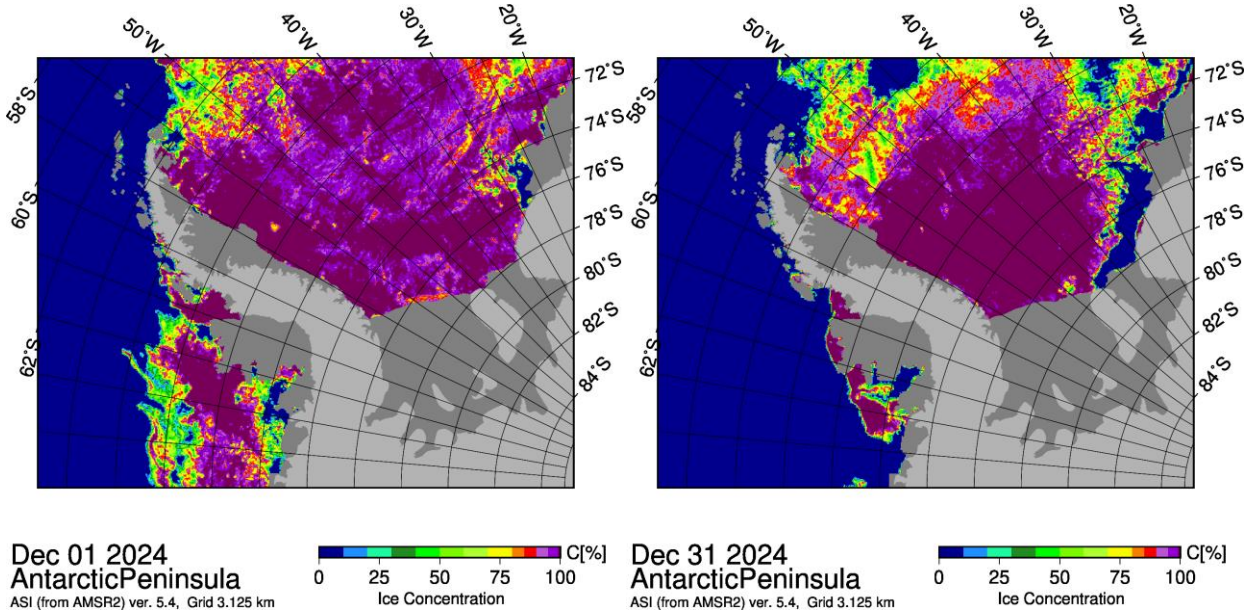

Figure 16- AMSR2 sea ice concentration maps from December 1st and December 31st, 2024.
Source: University of Bremen

Tide level, sea water conductivity, and sea water temperature data is archived on the AMRDC website: https://amrdcdata.ssec.wisc.edu/dataset?q=Palmer+Station.

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 at 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.

On December 5th, the Research Associate performed a service visit to AWS #3, located on Island #412 in the Gossler Islands group. The barometer tube was found to be disconnected from the DCP, which explained the erratic pressure readings that had been observed. The tube was reconnected and pressure readings stabilized. Unfortunately, a few hours later, the readings

became erratic again, suggesting that the tube did not stay in place. On the next visit, the tube will be reconnected and secured more tightly.

One minute weather data is archived on the AMRDC website: https://amrdcdata.ssec.wisc.edu/dataset?q=Palmer+Station.

Figure 17- AWS #3 on Island #412 of the Gossler Islands group. *Image credit: Ben Rosen-Filardo*

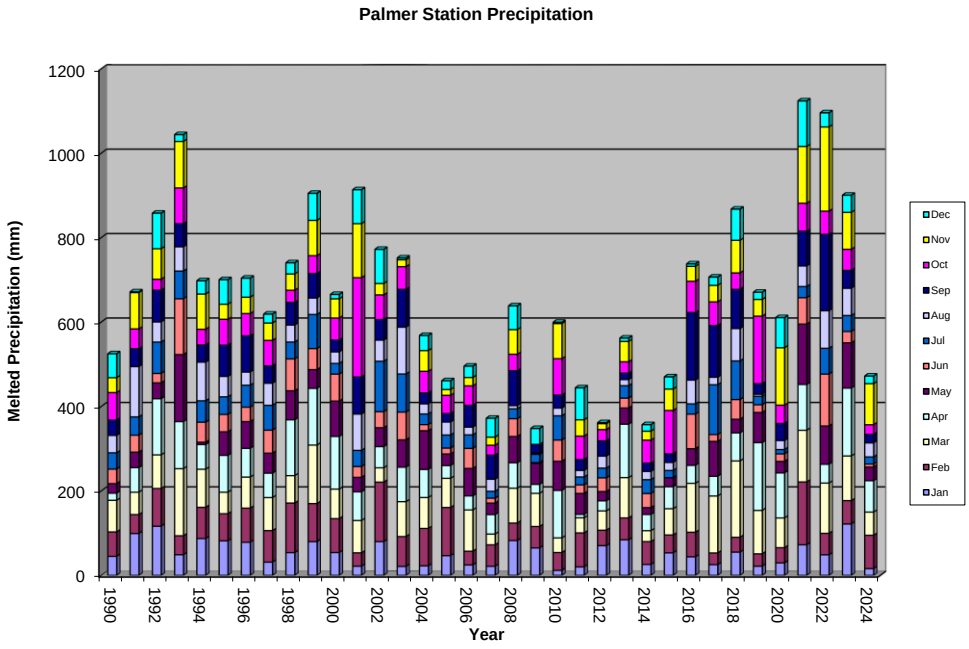

Figure 18- Palmer Station melted precipitation, 1990-2024.

Palmer Monthly Met summary for December 2024

Temperature
Average: 1.4 °C / 34.5 °F
Maximum: 7.6 °C / 45.68 °F on 24 Dec 16:02
Minimum: -3.2 °C / 26.24 °F on 9 Dec 03:36
Air Pressure
Average: 992.6 mb
Maximum: 1011.7 mb on 6 Dec 04:07
Minimum: 968.4 mb on 26 Dec 02:06
Wind
Average: 8.8 knots / 10.1 mph
Peak (5 Sec Gust): 50 knots / 57 mph on 25 Dec 23:07 from ENE (70 deg)
Prevailing Direction for Month: NNE
Surface
Total Melted Precipitation: 18 mm / 0.71 in
Total Snowfall: 0 cm / 0 in
Greatest Depth at Snow Stake: 103.6 cm / 40.4 in
WMO Sea Ice Observation: 11-20 bergs, bergy bits, growlers, brash ice. Hero Inlet is ice free.
Average Sea Surface Temperature: 0.46 °C / 32.8 °F

2024 was significantly drier than recent years, with only 472.1 mm of melted precipitation compared to 900.4 mm in 2023, 1095.6 mm in 2022, and a record-breaking 1123.8 mm in 2021. In fact, 2024 had the lowest total precipitation of any year since the installation of the PAWS backyard weather station in 2015. Relatedly, 2024 saw fewer days of northerly winds, which tend to bring the wettest weather.

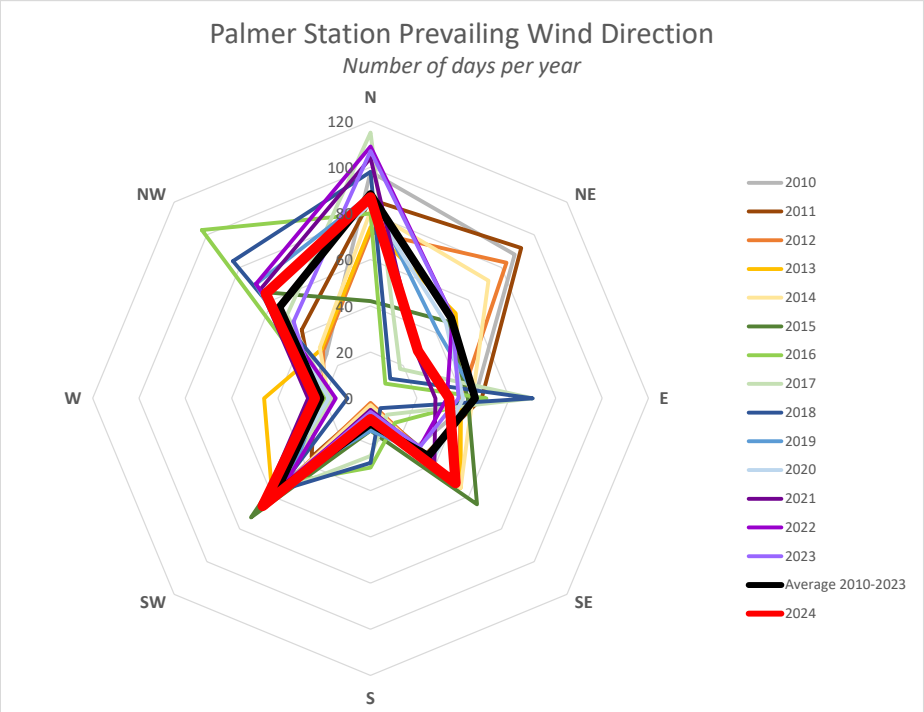

Figure 19- Simplified wind rose of Palmer Station prevailing wind direction, 2010-2024.

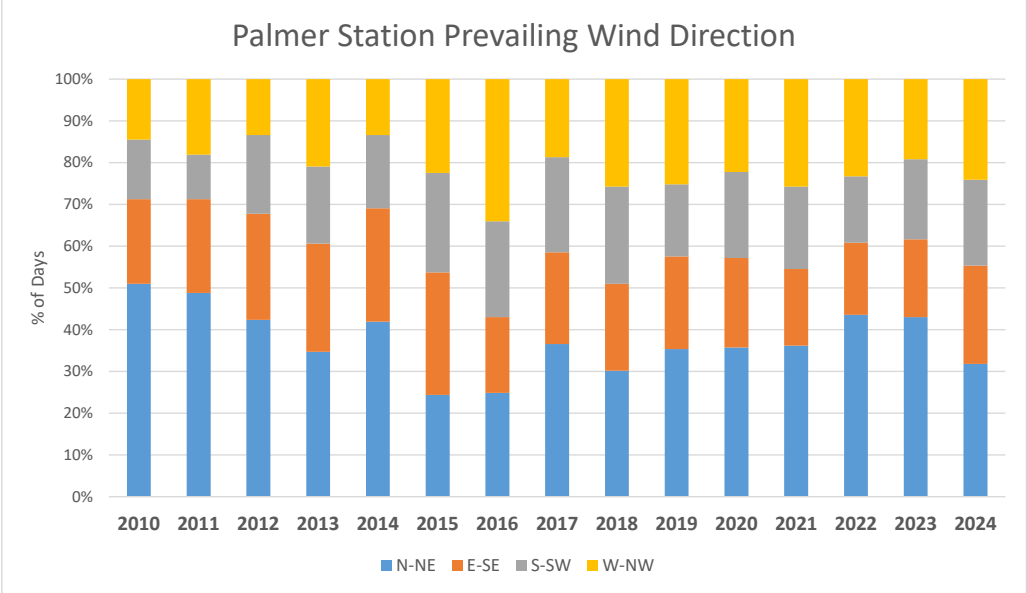

Figure 20- Bar chart of Palmer Station prevailing wind direction, 2010-2024.