PALMER MONTHLY SCIENCE REPORT

April 2025

Riggers in a zodiac heading out to Halfway Island to make repairs. Like the one pictured, we have had many large icebergs drift by just outside of Hero Inlet this month.
Photo credit: Ben Dillon

NEWS FROM THE LAB

Nora Jackson, Winter Laboratory Supervisor

April in the labs was a busy month as summer grantee groups and ASC staff departed on the R/V Noosfera, and the winter crew gradually became oriented to life and work here on beautiful Anvers Island. There are three new lab staff members here for the winter including myself, Luca Heritage the winter Instrument Technician, and Will Skorski the winter Research Associate. It is our first time to Palmer, and we have been lucky enough to see some spectacular sunsets and sunrises, as well as seals, penguins, and whales all in our first month! As the station has started to quiet down for the winter, we have taken on preventative maintenance projects and even begun preparing materials and instruments for the 25/26 summer season which will be here before we know it.

We have continued to support a group of Riggers in the BioLabs as they take every weather opportunity to work on island and backyard weather and communication towers. The Hazardous Waste team is also making use of the BioLab spaces as they prepare for the arrival of R/V

Nathaniel B. Palmer in early May. As able, Hannah James (Summer Lab Manager) and Barbara Krasinski (Summer Boathouse Manager) have continued monitoring Giant Petrel fledglings on Humble Island for C-013-P (Cimino). Throughout the month, we saw cormorants, small flocks of Antarctic terns, and an enigmatic pair of sheathbills that regularly amble up the road up to Terra Lab or perch on the Boathouse roof.

Despite the busy turnover weeks and some projector malfunctions, we continued with Science Tuesday talks featuring Satellite Communications Engineer Evie Look, Rigger Ben Rosen-Filardo, and Summer Lab Manager Hannah James. We learned about the summer field work here at Palmer, the New York City subway, and turbomachinery at NASA. I would like to extend my thanks to the Palmer summer crew whose assistance, patience, breadth of knowledge has been indispensable as we transition into the winter season. In particular, Luca, Will, and I would like to thank Hannah James for all of her help and support during turnover. Thank you for setting us up so well for a successful winter season.

PALMER STATION RESEARCH ASSOCIATE MONTHLY REPORT – April 2025
William Skorski, Winter Research Associate

Mount Matin, sitting at 7,920 feet above sea level, as the first rays of sun illuminate its peak during a beautiful sunrise on April 23rd 2025.
Image credit: William Skorski

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 measure 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).

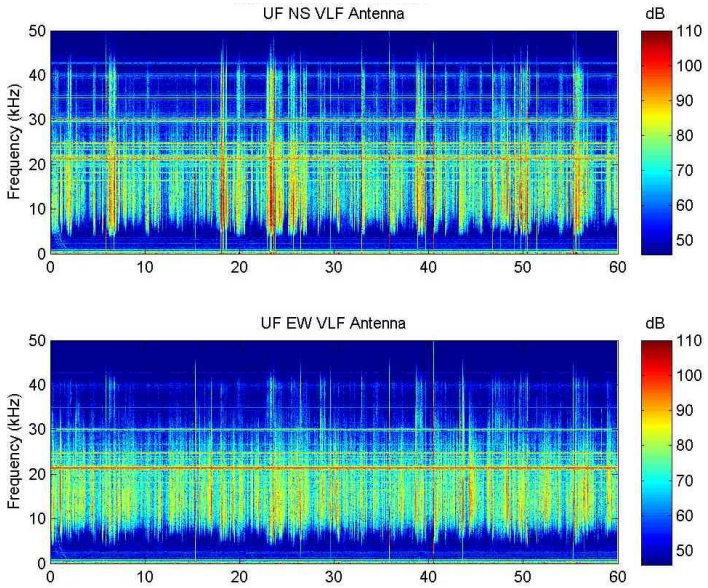

Figure 1. Real-Time broadband VLF and ELF Spectrogram from Palmer Station, Antarctica.

It has been an up and down month for the ELF/VLF computer. Due to some computer storage issues, data collection has been paused. Troubleshooting and collaboration with the PIs will continue in May to ensure data collection resumes. Bi-weekly antenna inspections were done as weather allowed to ensure the system is running smoothly for when we get the computer back online.

PIs are also working on getting real-time data display back online. When online, current ELF/VLF 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, 2024 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.

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 Earthquake monitoring site.

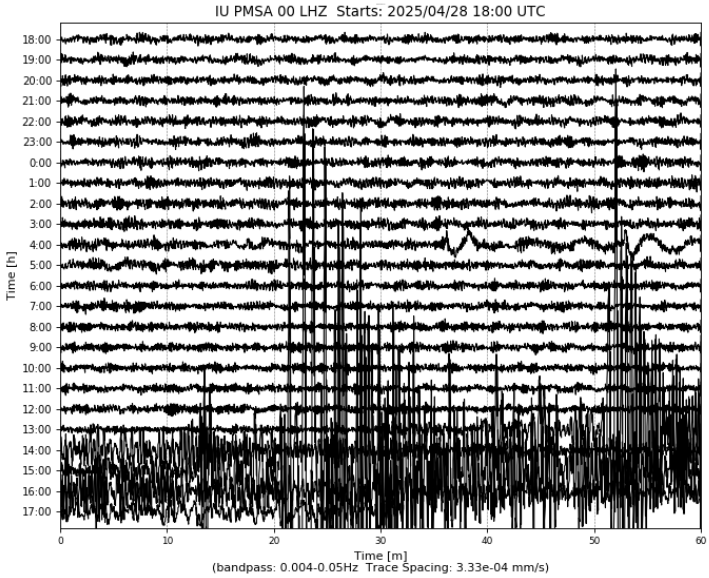

Figure 3. An April 29th magnitude 6.8 earthquake in the Macquarie Island region, 1391.2 km off the coast of Queenstown New Zealand in the Pacific Ocean (54.327S, 155.677E) as recorded from the Palmer seismic station.

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.

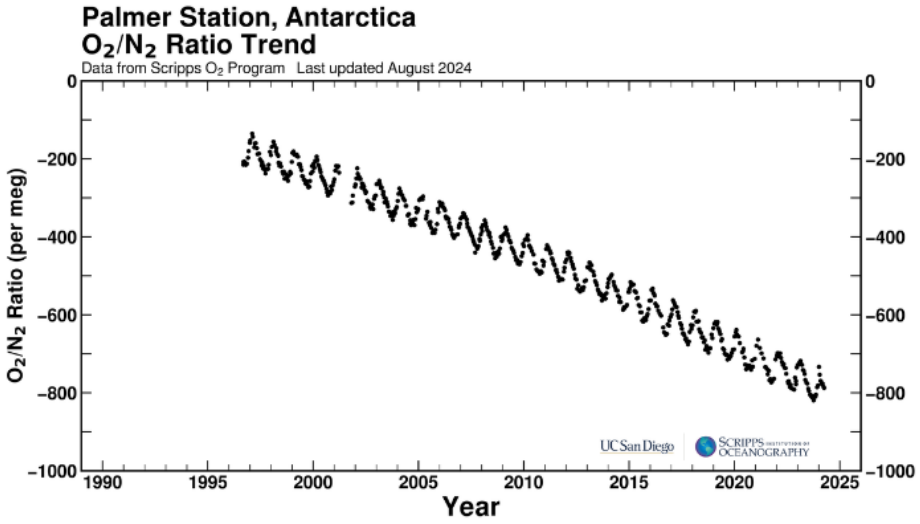

Figure 2. Historical plot of $\mathbf{O_2/N_2}$ ratio per meg and $\mathbf{CO_2}$ ppm, updated August 2024.

Air samples were collected on April 6th and April 16th. 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, in vehicles, 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 April 2nd, 7th, 14th, 21st, and 28th during favorable wind conditions. More information and data for the Carbon Cycle group can be found at: https://gml.noaa.gov/ccgg/.

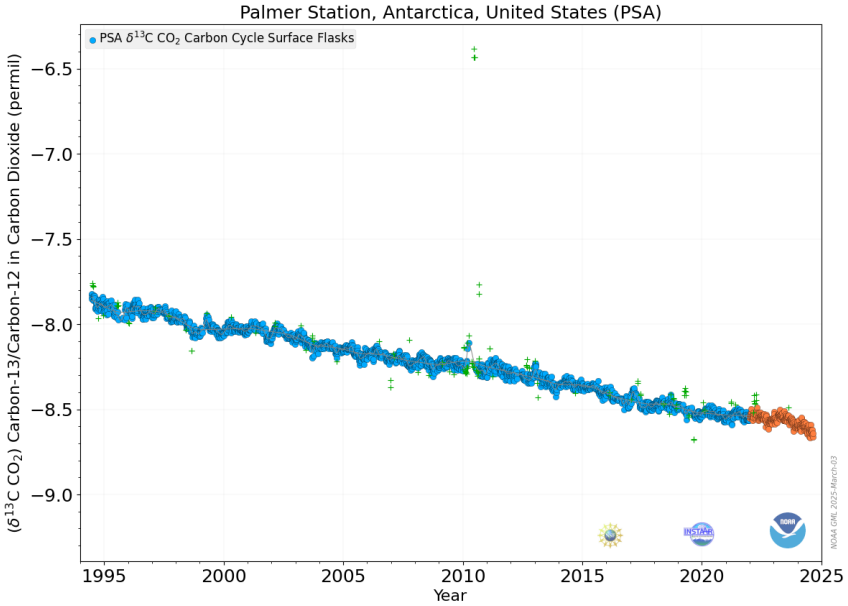

Figure 3. Carbon-13/Carbon-12 in Carbon Dioxide (δ13C-CO2) levels at Palmer Station dating back to 1994. Orange dots are preliminary data and green pluses are poorly mixed air masses, which should not indicate background conditions.

HATS samples were collected on April 12th and April 24th during favorable wind conditions. All samples collected on station are sent back to the Earth System Research Laboratories in Boulder, Colorado for analysis. More information and data for the Halocarbons and other Atmospheric Trace Species group can be found at: https://gml.noaa.gov/hats/

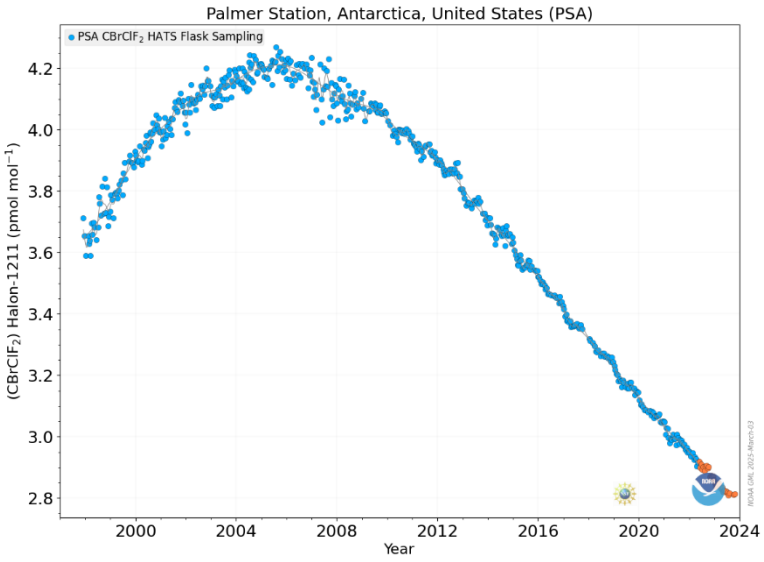

Figure 4. Halon-1211 ($CBrClF_2$) levels dating back to 1997, one of the Halocarbon and Trace Gases measured at Palmer Station. Orange dots are preliminary data.

With three different atmospheric sampling projects, five different sampling locations, and variable wind conditions at Palmer Station, Palmer RA Will Skorski created a new sampling dashboard to better track wind trends to ensure optimal sampling can occur.

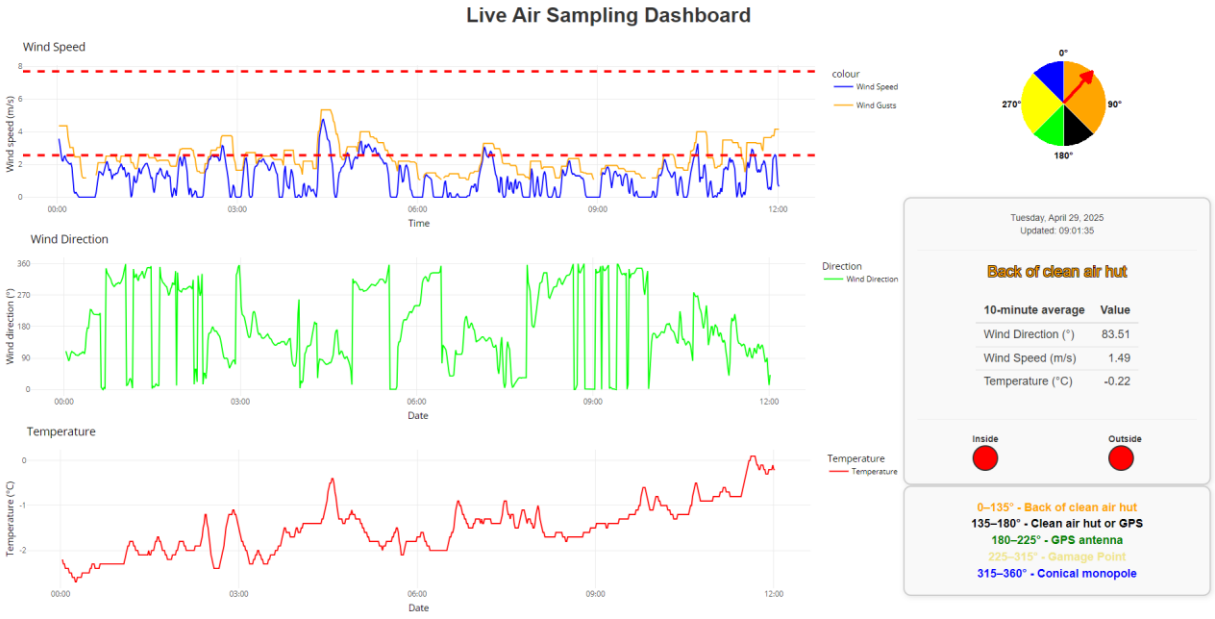

Figure 5. Air sampling dashboard which displays wind speed and wind gusts (m/s), wind direction, and air temperature (C) in graphical form (left), as well as 10-minute averages of each variable (right). The "Inside" and "Outside" circles turn green when atmospheric conditions are within sampling criteria. The compass in the upper right and key in the bottom right are used to track where outdoor sampling will take place when conditions are met. The dashed red horizontal lines in the wind graph represent the upper and lower limit wind speeds required for sampling.

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.

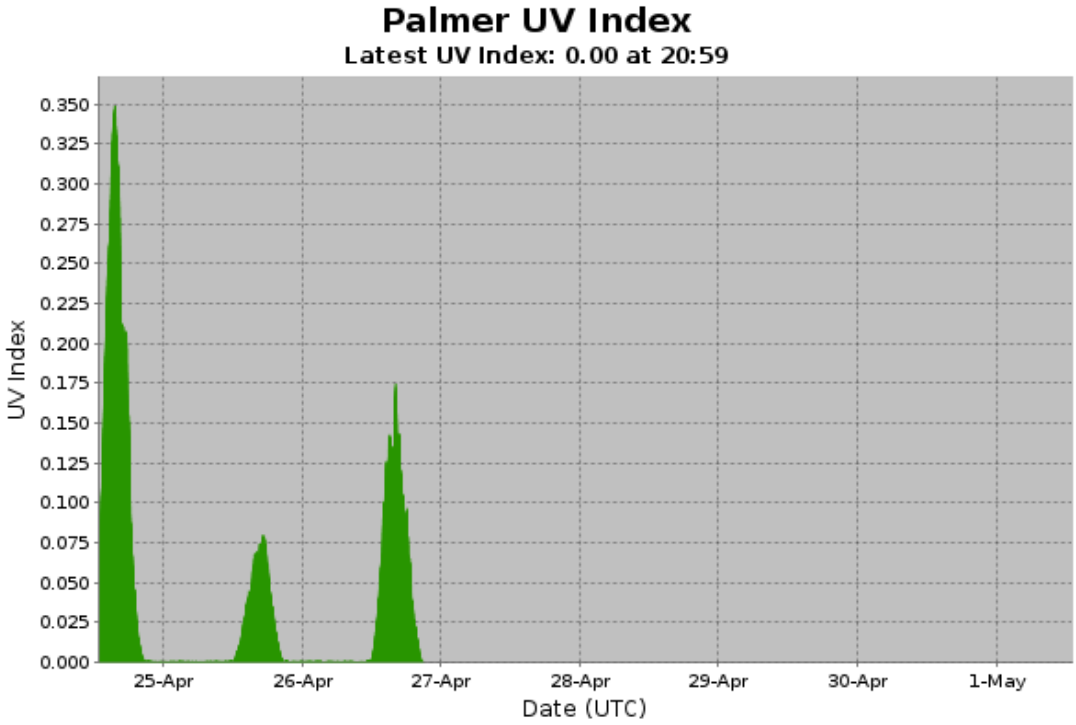

Figure 6. UV index generated from the GUV-511 radiometer in real time.

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 April 12th and April 24th without issues. The connector on the TUVR is broken, and the instrument has been intermittently reporting since November 5th, 2024. Additionally, on April 28th the UV index graphs have stopped displaying data and the PIs have been contacted to solve this issue. Spoilers for May – the data is displaying correctly again as of May 1st!
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.

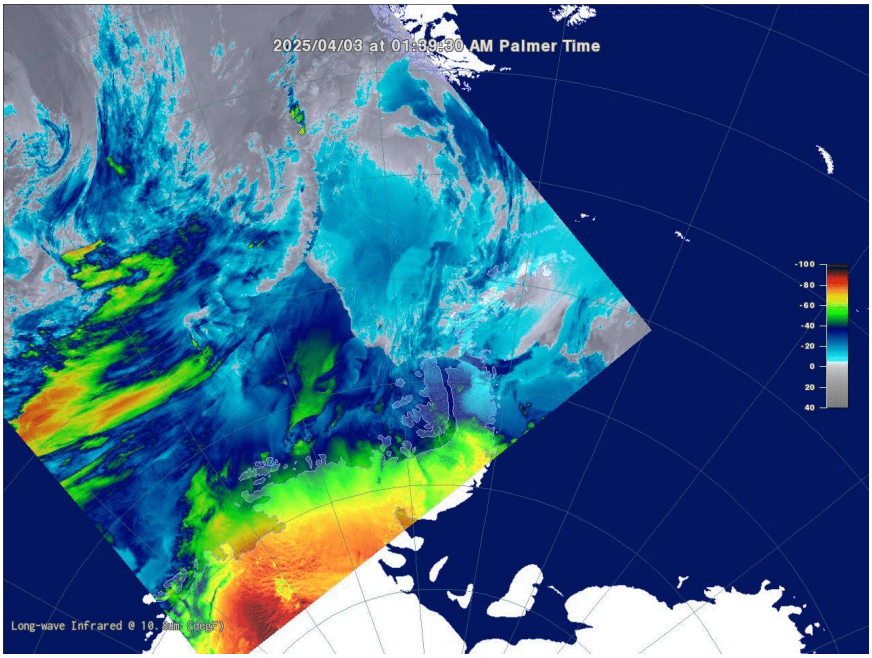

Figure 7. Met-Op 3 April 3rd satellite pass.

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 Station. The Research Associate may offer support to visiting grantees at their discretion. 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 and packed for 2025 Q2. The monthly log was sent on time. 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. Tide prediction data for the arrival of the R/V Nathaniel B. Palmer was sent to the marine techs onboard to help prepare for a successful port call in early-mid May. We await their arrival with excitement and anticipation. Be sure to check the Palmer webcam to see the arrival of the NBP around May 10th.

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.

As the sun starts to rise and set earlier, the AWS stations located away from Palmer Station start to go down for the winter. The base station and AWS1 (Wauwerman) have been operating nominally for the month. AWS2 (Joubins) is down due to radio communication issues. AWS3 (Gossler) is down because we have not had enough sunlight to power the solar panel. The AWS Base station on Anvers Island required a replacement wind rotor, and since mid-April has been working well. One-minute weather data is archived on the AMRDC website: https://amrdcdata.ssec.wisc.edu/dataset?q=Palmer+Station.

Palmer Monthly Met summary for April, 2025

Temperature
Average: 1.1 °C / 33.9 °F
Maximum: 7.4 °C / 45.32 °F on 21 Apr 03:55
Minimum: -4.8 °C / 23.36 °F on 2 Apr 00:58
Air Pressure
Average: 990.2 mb
Maximum: 1009.5 mb on 14 Apr 13:12
Minimum: 964.3 mb on 27 Apr 21:52
Wind
Average: 13.2 knots / 15.2 mph
Peak (5 Sec Gust): 65 knots / 75 mph on 27 Apr 21:56 from NNE (32 deg)
Prevailing Direction for Month: NNE
Surface
Total Melted Precipitation: 118.6 mm / 4.67 in

Total Snowfall: 19 cm / 7.4 in
Greatest Depth at Snow Stake: 10 cm / 3.9 in
WMO Sea Ice Observation: 11-20 bergs, bergy bits, growlers, brash ice
Average Sea Surface Temperature: .22 °C / 32.4 °F

Coming in at the eighth wettest April on record, we saw a dramatic increase in total melted precipitation, reaching 118.6 mm for the month. Conversely, snowfall only contributed to 19 cm of that figure, the fifth lowest total snowfall for the month of April at Palmer Station on record dating back to 1990. We also experienced many days with high winds, including 19 days where winds exceeded 30+ knots (tied for fifth most in April on record).

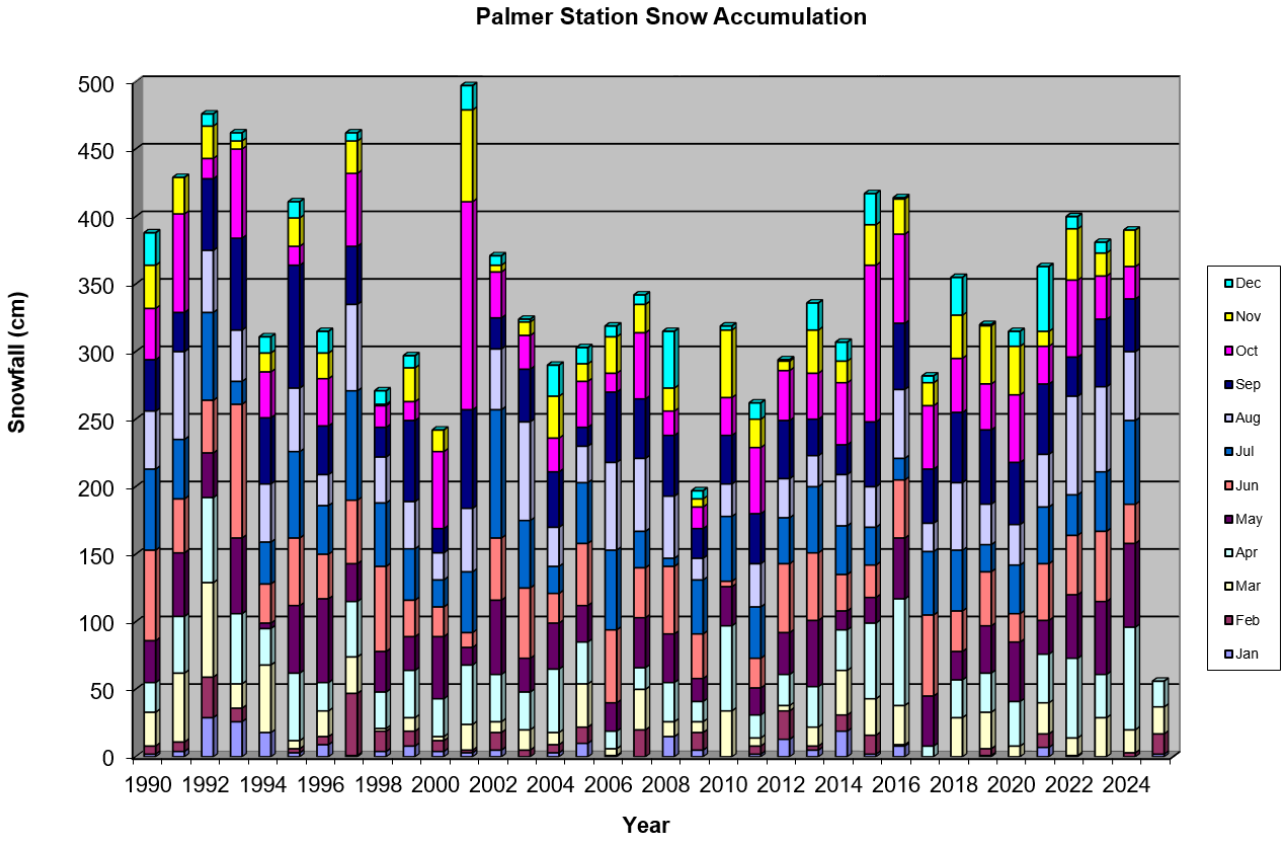

Figure 8. Palmer Station snow accumulation, 1990-present.

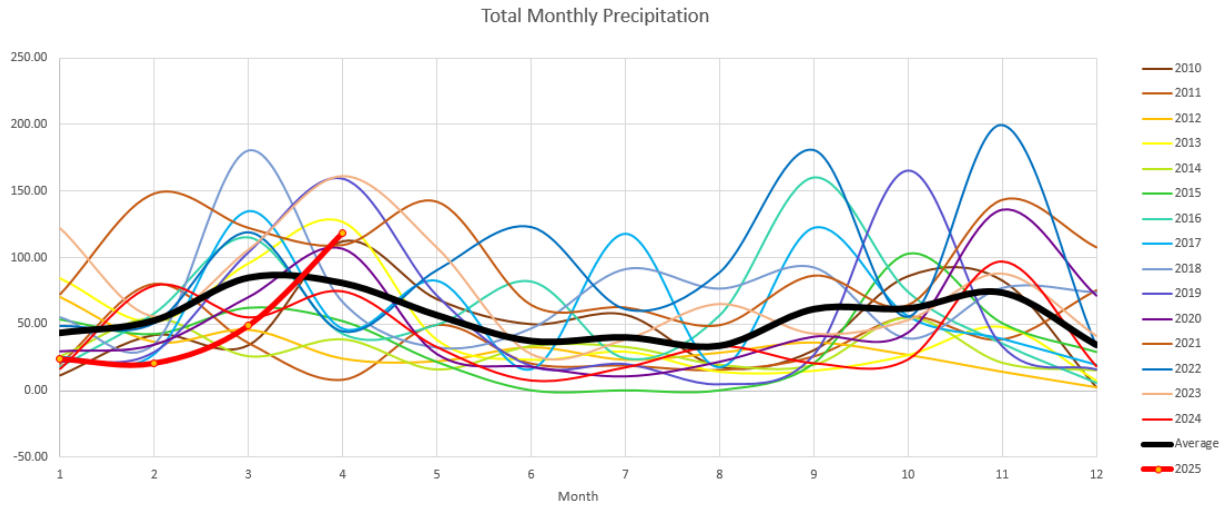

Figure 9. Palmer Station monthly precipitation, 2010-present.

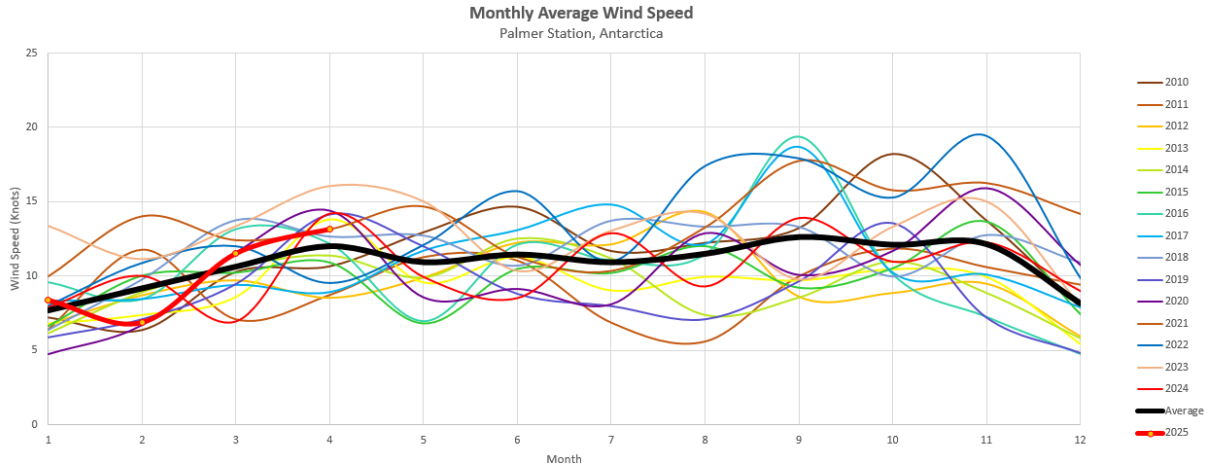

Figure 10. Palmer Station monthly average wind speed, 2010-present.

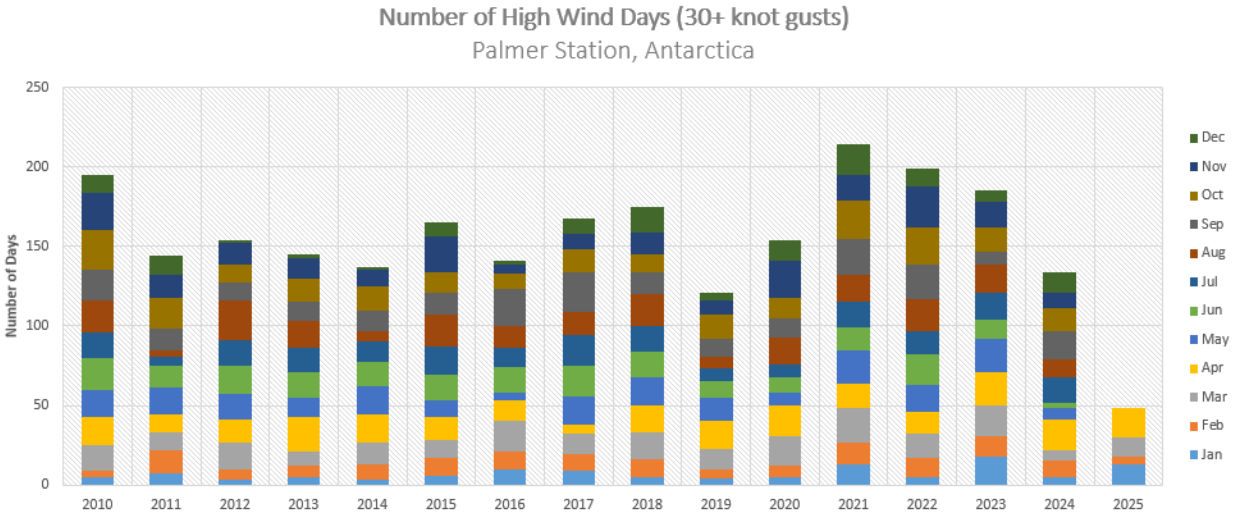

Figure 11. Number of high wind days (gusting 30+ knots) at Palmer Station, 2010-present.