PALMER MONTHLY SCIENCE REPORT
May 2025

Complete rainbow shining over Bonaparte Point after a series of cloudy days.
Photo credit: Ben Dillon

NEWS FROM THE LAB
Nora Jackson, Winter Laboratory Supervisor

While we certainly had April showers, they did not bring May flowers to Palmer Station; although, recently we were lucky to see a complete rainbow over Bonaparte Point which more than made up for the lack of flowers. The main event of May, on station and in the labs, was a busy visit from the R/V *Nathaniel B. Palmer* which brought cargo and picked up samples and the remaining summer crew. The port call went smoothly in large part thanks to the Logistics and Waste teams on station, and with the help of many other hands. As for the BioLabs and Terra Lab spaces, we were relieved to get our samples northbound and on their way home.

A team of people remaining on station have continued to check on the Giant Petrel fledglings on Humble Island for C-013-P (Cimino). On May 16th, we were still observing a few fledglings lingering at their nests. Just a few days later, May 22nd, we observed no young birds, just a few practicing adults. Stranger still, May 22, 2024 was also the final day the birders visited Humble Island last year.

Like fledgling Giant Petrels taking to the sky, we, here at Palmer, enter into the winter season with eagerness for projects large and small, snow shoveling, and with preparations already underway for the summer. Seemingly just a few days after the R/V *Nathaniel B. Palmer* departed, we learned of an upcoming visit from the RRS *Sir David Attenborough*, a polar research vessel operated by the British Antarctic Survey (BAS). We all enjoyed the opportunity to tour the ship, dine in the ship's galley on fish n' chips, and purchase merchandise from the store. At 12 stories high, the view from the bridge made Palmer Station look very small indeed. The ship also brought our final winter crew member bringing the station population up to 20. Groups of crew and passengers went on tours of Palmer Station, hiked in the backyard, and visited the Palmer Store. We were honored to welcome the RRS *Sir David Attenborough* and will think fondly of the visit, especially while we enjoy the freshie order they delivered.

In other news, Science Tuesday evenings continue to be well-attended and on a wide range of topics. This month we heard from Will Skorski, Research Associate, on Stable Water Isotopes in Greenland air, Casey Turner, FMC Coordinator, on chess, and myself, on Oceanographic Science at sea. Last week, we had two special guests for Science Tuesday; James and Tripp Driskell X-605-M/S/P (Driskell) called in to talk to Palmer about their research studying "Dyads and Triads at 140 Million Miles: Factors Affecting Interpersonal Relations in Long-Duration Spaceflight." Part of their study includes volunteers at Palmer Station completing journal entries and surveys about the formation of interpersonal bonds over this winter season.

As the RRS *Sir David Attenborough* pulled away from the pier and as we enter the darkest month, it feels as though winter has truly arrived. Work in the labs can focus on inventory and maintenance projects, as the pace of life on station slows down. We are looking ahead to many fun winter events and more opportunities to experience the natural beauty around us in low light and under skies filled with stars.

The RRS *Sir David Attenborough* preparing to dock at the pier on May 30th.
Photo credit: William Skorski

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

May was an exciting month up at Terra Lab. On May 2nd, we observed a 7.5 magnitude earthquake in the Drake Passage, only ~900 km (550 miles) from Palmer Station. Due to the intensity and proximity, the earthquake produced a robust looking Heliplot. We could also see the after-effects in our tide gauge data showing deviations up to 0.5 feet.

In addition, coordination between the RA and ELF/VLF PIs proved fruitful, as data is now being processed and sent back to PIs at the New Jersey Institute of Technology (NJIT) and the University of South Florida (USF) for analysis. The CTBT system operated consistently this month, and preparations are being made for the annual filter roll change that will occur in the next month or two. On the meteorological side, we saw an increase in snow (yay!) and a decrease in both air temperature and high wind days. Additionally, throughout the month the NOAA Carbon Cycle, Halocarbons, and Scripps O2/N2 samples were taken as winds permitted.

To end the month, during the RRS *Sir David Attenborough* visit, Terra Lab hosted 35 visitors over five tours during this distinguished visit, highlighting the lab's critical long-term data collection efforts.

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.

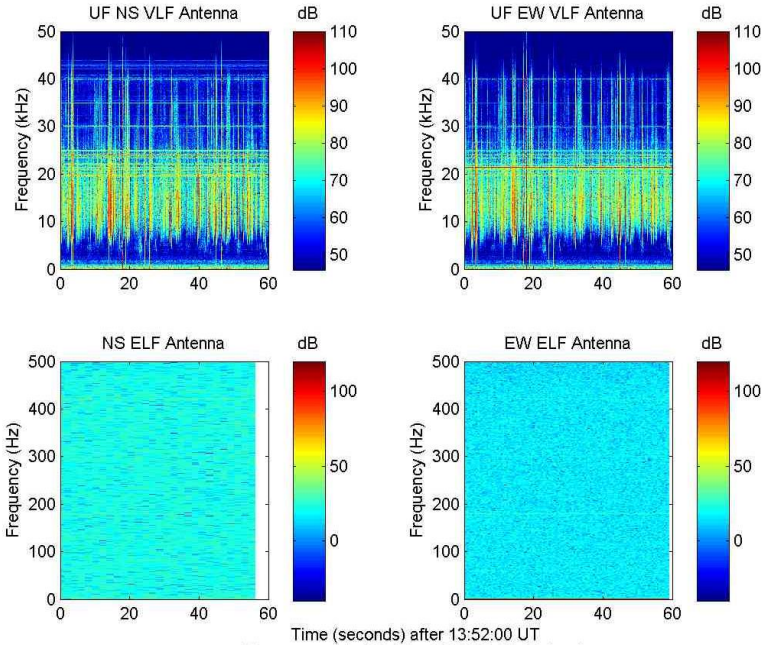

Figure 1. Real-Time broadband VLF and ELF Spectrogram from Palmer Station, Antarctica.

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).

ELF/VLF data flow has been restored thanks to efforts from the PIs (namely James Camp at the University of Florida)! The VLF data flow has returned to normal, but troubleshooting work on the graphical representations of ELF data will continue. Bi-weekly antenna inspections were done as weather allowed to ensure the system is running smoothly.

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 through 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.

With the arrival of the R/V *Nathaniel B. Palmer,* we received the equipment needed to replace the Episensor and batteries in the seismic hut. Work will be done to replace these broken components when the snowpack is deeper to allow movement of heavy cargo via snowmobile. Look for an update on this in our next monthly report!

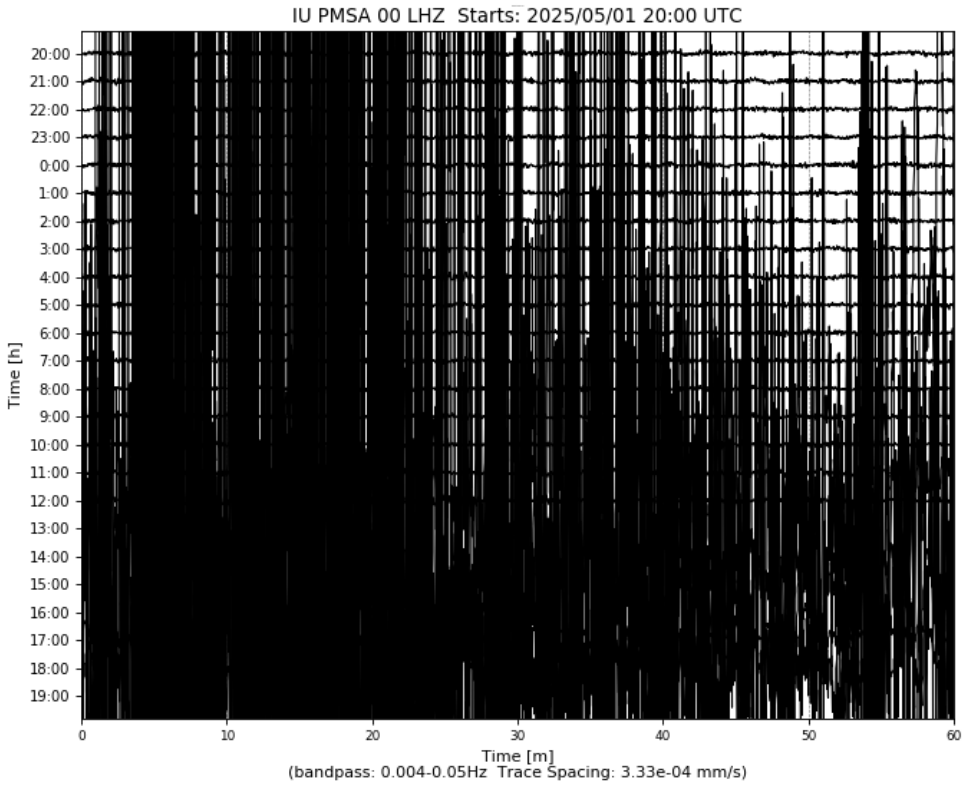

Figure 2. On May 2nd, a magnitude 7.5 earthquake registered in the Drake Passage, ~900 km (560 miles) from Palmer Station as recorded from the Palmer seismic station.

May brought us an exciting earthquake event, as we experienced small-scale tidal affects due to a 7.5 magnitude earthquake in the Drake Passage. Typically, earthquakes are much farther from us so we don't get to see their effects. If you are interested, check out the "Physical Oceanography" section later in this document to see how this earthquake affected our local tides.

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.

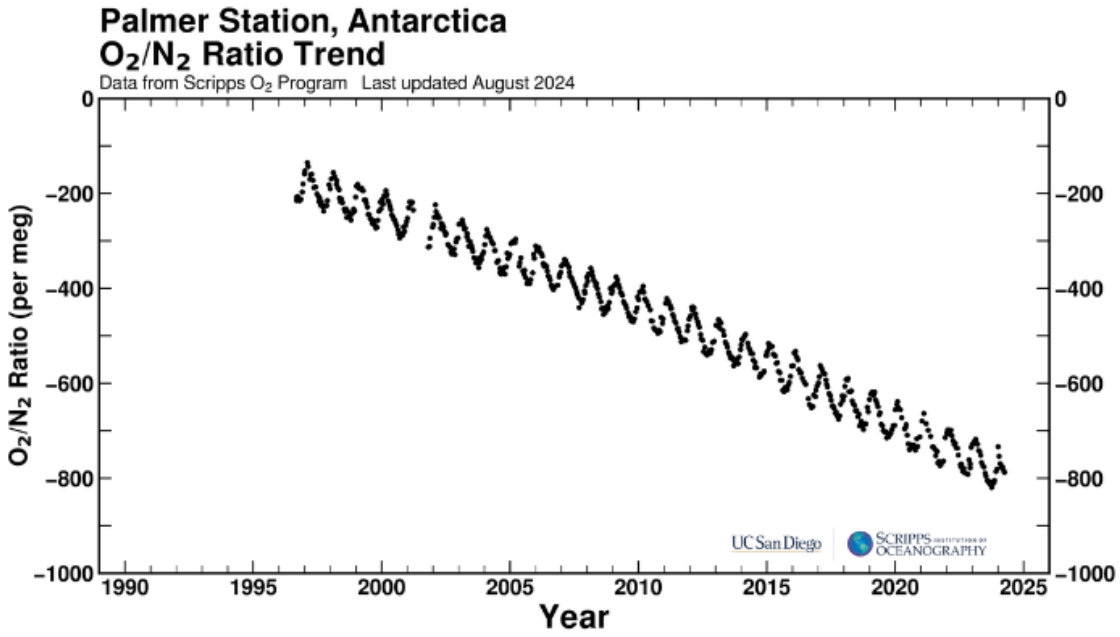

Figure 3. Historical plot of O_2/N_2 ratio per meg and 〖CO〗_2 ppm, updated August 2024.

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.

Air samples were collected on May 15th and May 23rd. 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.

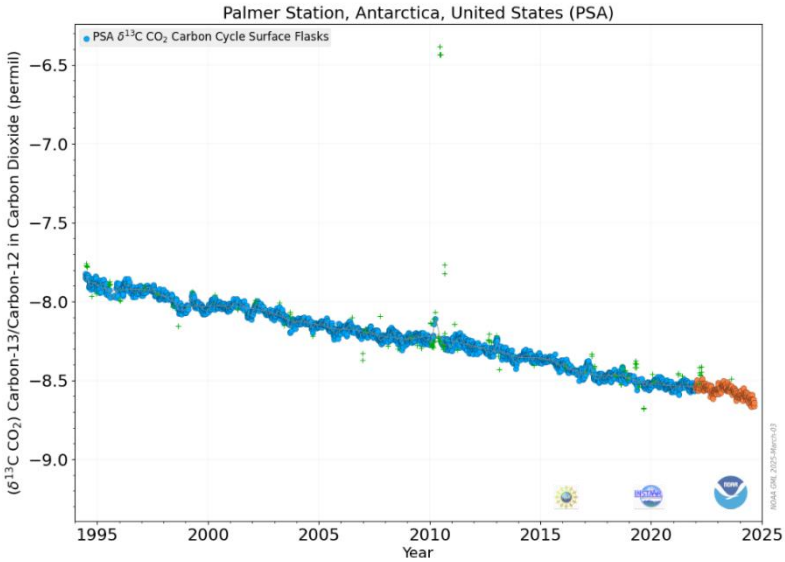

Figure 4. Carbon-13/Carbon-12 in Carbon Dioxide (δ13C-CO2) levels at Palmer Station dating back to 1994. Orange dots are preliminary data and green pluses are poorly mixed air masses, which should not indicate background conditions.

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 May 5th, 17th, 23rd, and 29th during favorable wind conditions. We had a long stretch of calm winds (<5 knots) which modified the CCGG sampling schedule. We are slowly moving the sampling schedule back to Mondays as wind speeds allow. More information and data for the Carbon Cycle group can be found at: https://gml.noaa.gov/ccgg/.

HATS samples were collected on May 11th and May 26th 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/

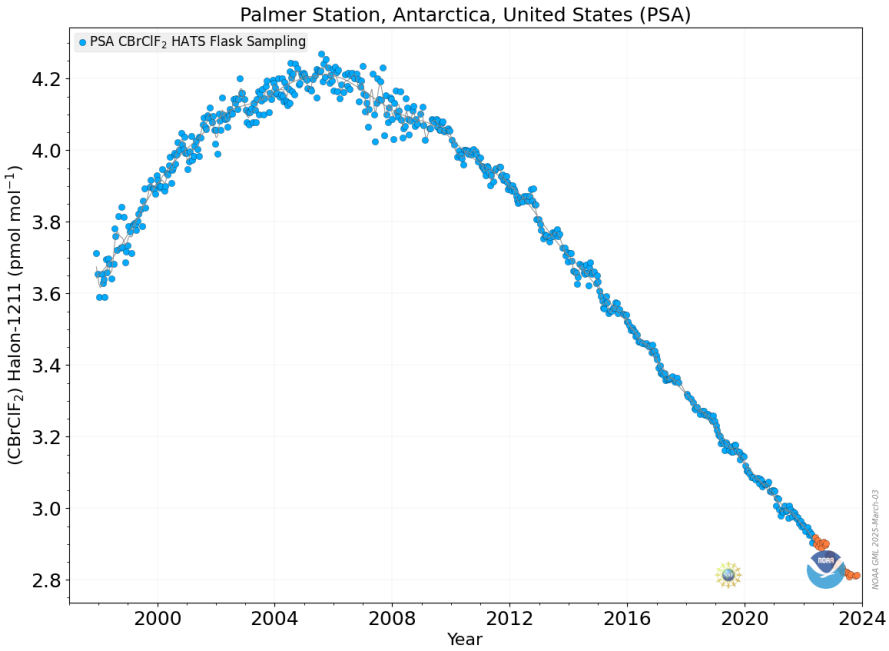

Figure 5. Halon-1211 (CBrClF2) levels dating back to 1997, one of the Halocarbon and Trace Gases measured at Palmer Station. Orange dots are preliminary data.

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.

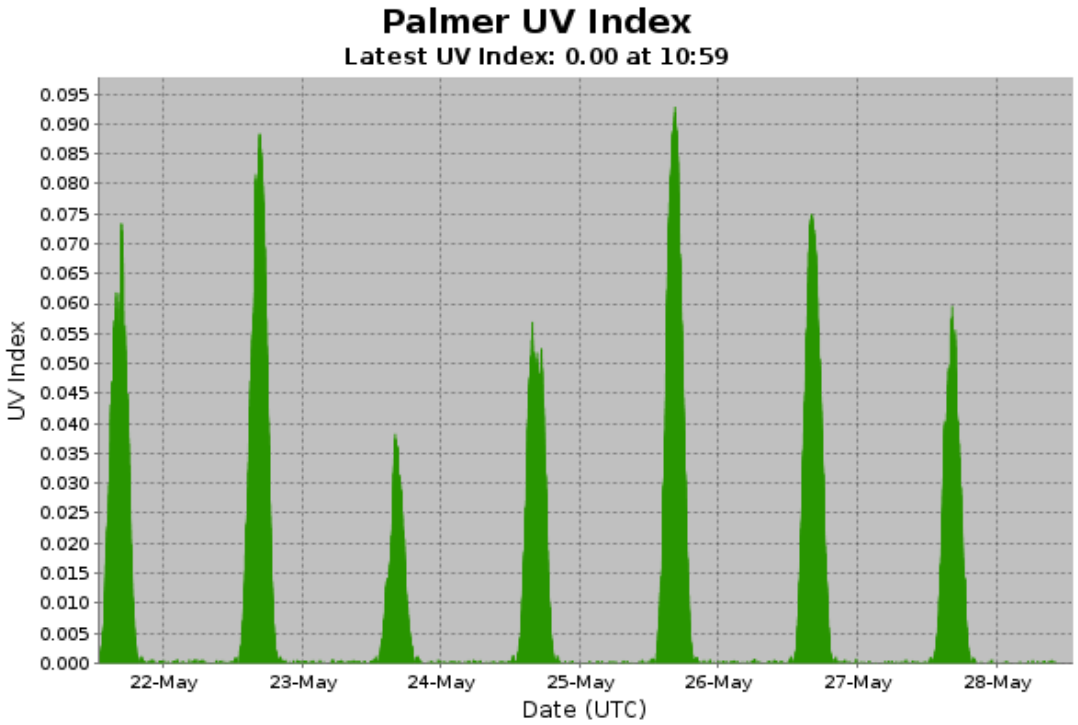

Figure 6. UV index generated from the GUV-511 radiometer in real time.

As reported in last month's report, the SUV data graph is back up and running. 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 has not been sent out for a couple weeks because access to the Palmer Station Drive has been lost on the SUV computer. Work is being done to fix this issue. SUV-100 Absolute Scans were performed on May 7th and May 21st without issues. The connector on the TUVR is broken, and the instrument has been intermittently reporting since November 5th, 2024.
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.

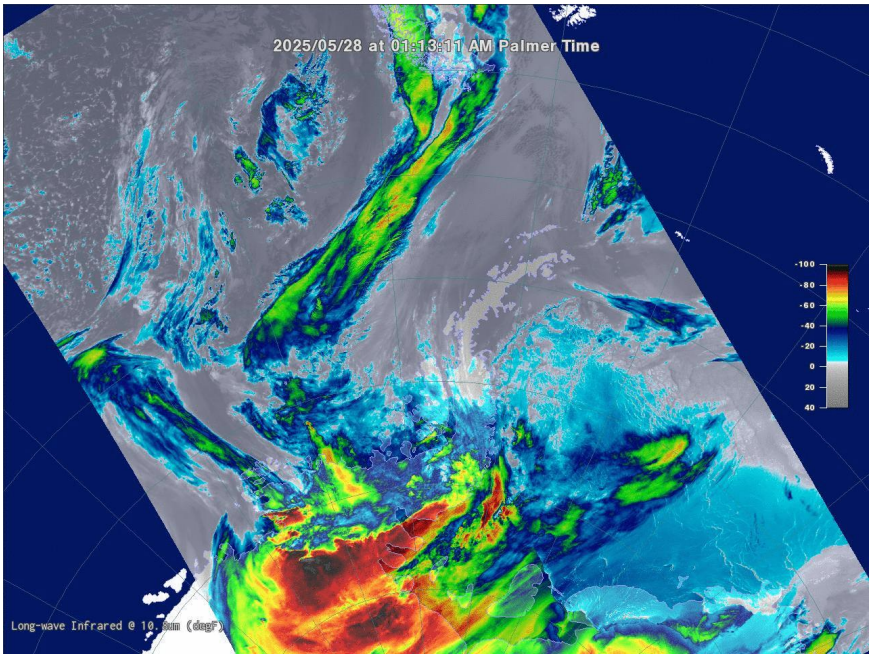

Figure 7. NOAA-18 May 28th satellite pass.

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. 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. We were able to remove the tide gauge from the water to clean off bioaccumulation on the sensors. This was completed on May 20th. Work still needs to be done to replace the Digi receiver.

As mentioned in the Seismograph section, a 7.5 magnitude earthquake occurred only 900 km from station. Looking at our tide gauge data, we can see a disturbance in our tide data (dark blue) compared to our prediction line (light blue). Looking at the figure, we can see the typically smooth tide line meld into a much more erratic signal after the earthquake (and its subsequent aftershocks) happened.

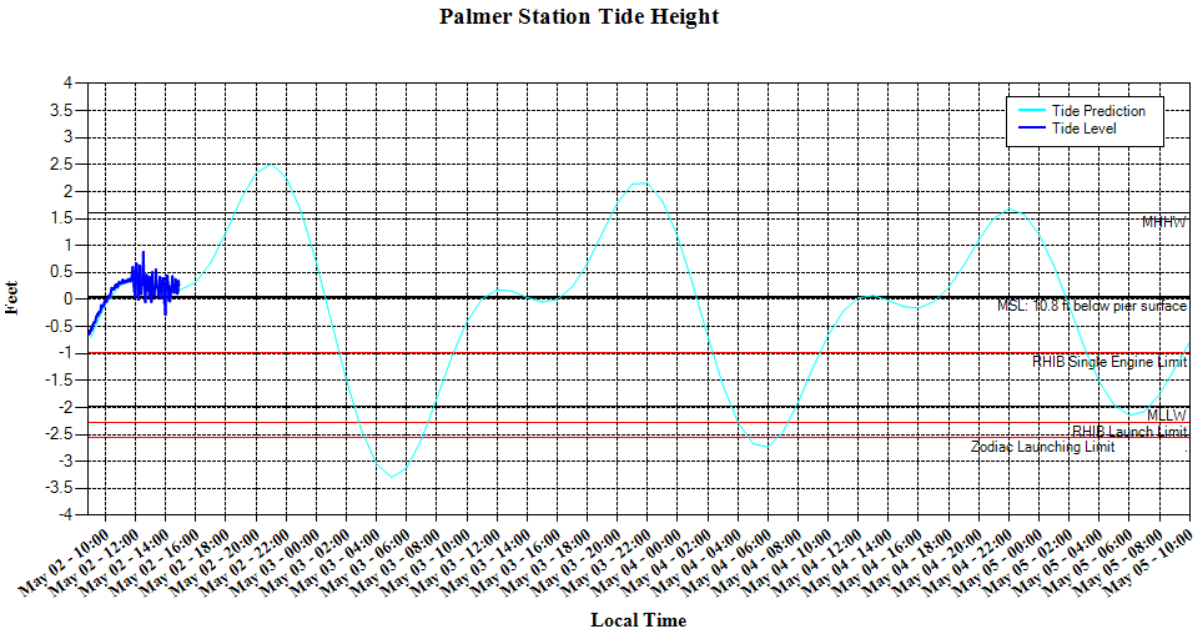

Figure 8. Palmer Station tide gauge data on May 2nd during the earthquake.

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.

Winter is finally here as we settle in to a colder climate with snow staying on the ground after our first snowfall of the month on May 5th. After what felt like a snowless April, May was the 6th snowiest month dating back to 1990 for Palmer Station. As expected with an increase in snow, we also experienced a colder monthly average air temperature, aligning with the average for the last 15 years. Additionally, May brought calmer winds: 4 days with gusts above 30 knots compared to 18 last month. One-minute weather data is archived on the AMRDC website: https://amrdcdata.ssec.wisc.edu/dataset?q=Palmer+Station.

Palmer Monthly Met summary for May, 2025

Temperature
Average: -1.8 °C / 28.8 °F
Maximum: 4.9 °C / 40.82 °F on 12 May 15:21
Minimum: -7.9 °C / 17.78 °F on 29 May 02:36
Air Pressure
Average: 995 mb
Maximum: 1018.6 mb on 27 May 10:24
Minimum: 964 mb on 13 May 03:17
Wind
Average: 6.1 knots / 7 mph
Peak (5 Sec Gust): 60 knots / 69 mph on 13 May 03:01 from N (1 deg)
Prevailing Direction for Month: SE
Surface
Total Melted Precipitation: 33.5 mm / 1.32 in
Total Snowfall: 53 cm / 20.7 in
Greatest Depth at Snow Stake: 35.6 cm / 13.9 in
WMO Sea Ice Observation: 11-20 bergs, bergy bits, growlers, brash ice
Average Sea Surface Temperature: -.74 °C / 30.7 °F

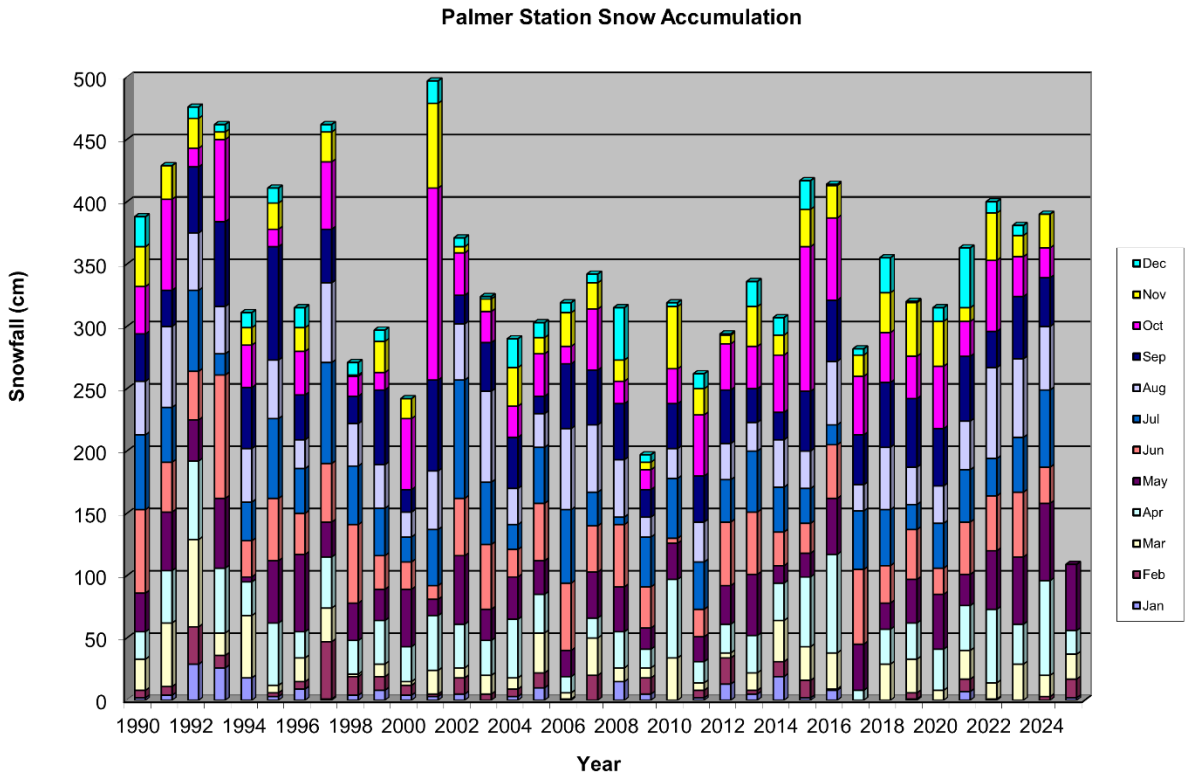

Figure 9. Palmer Station snow accumulation, 1990-present.

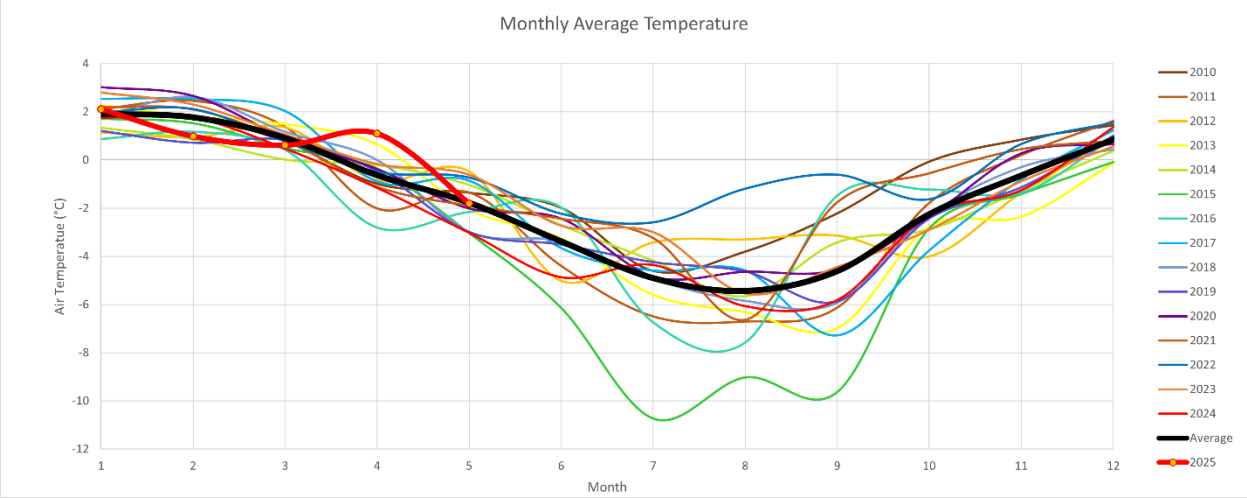

Figure 10. Palmer Station monthly average temperature, 2010-present.

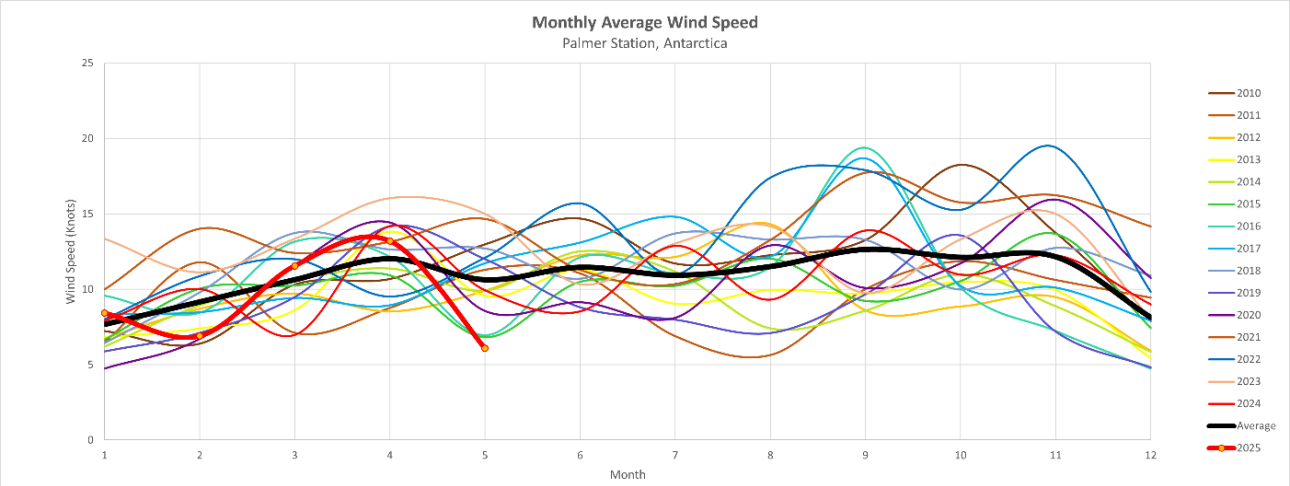

Figure 11. Palmer Station monthly average wind speed, 2010-present.

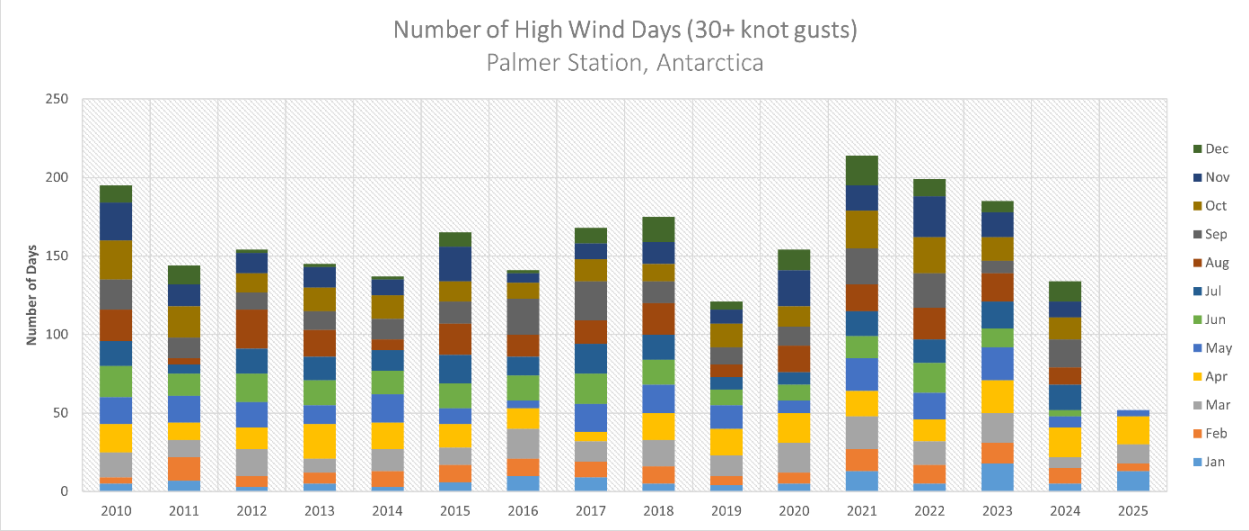

Figure 12. Number of high wind days (gusting 30+ knots) at Palmer Station, 2010-present.