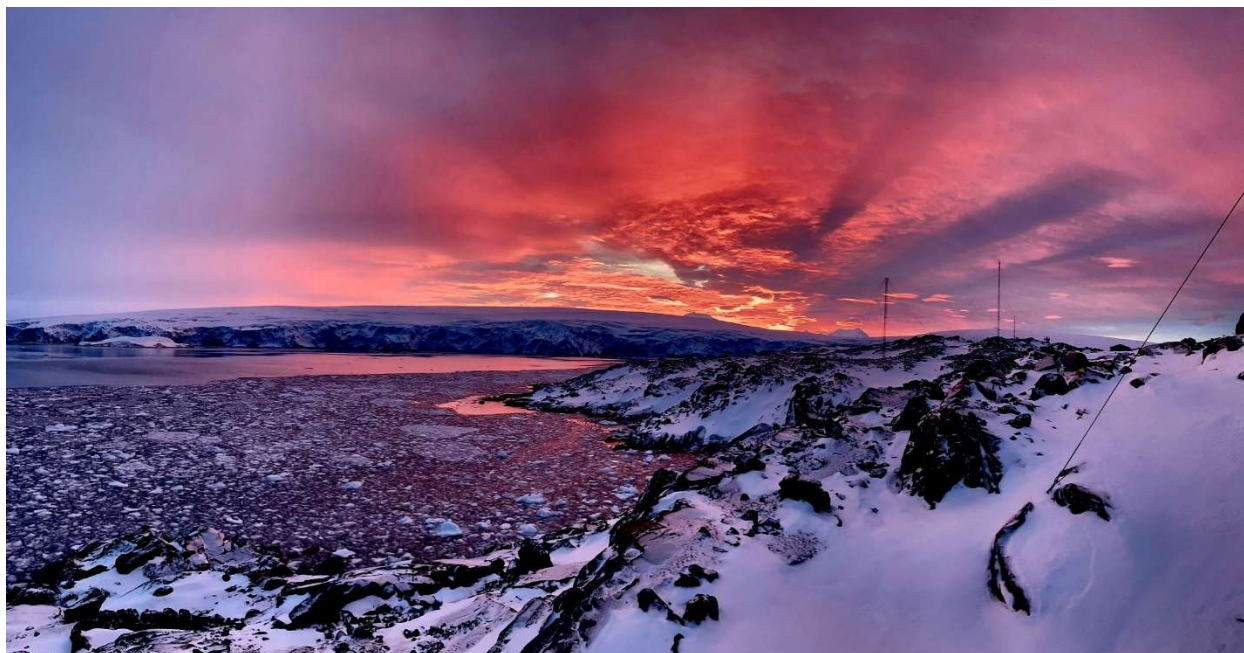


PALMER STATION MONTHLY SCIENCE REPORT

April 2024



A late seasonal sunrise overlooking Arthur's Harbor. The sun is adding it last bits of warmth to the Palmer Station winterovers. Image credit: Randal Rhodes

NEWS FROM THE LAB

Sallie Anderson, Winter Laboratory Supervisor

April showers brought a beautiful double rainbow to Palmer Station. As well as, breathtaking golden hour views for sunrises and sunsets. There was a lot of excitement when the R/V Laurence M. Gould arrived on April 4th with the Palmer winterover staff and several Denver support staff. During the LMG port call we had Environmental conducting annual drinking water testing as well as a site visit from the Medical Director for USAP.

The FMC team stayed throughout April, completing annual maintenance on alarms and special hazard fire safety systems, installing the new standby generator, and reviewing our critical water systems. They have contributed a lot to the community, but had to catch their ride home on the R/V Nathaniel B. Palmer when it docked at Palmer Station on April 30th.

The Palmer ad-hoc bird watching team has continued the giant petrel chick count and weights since the departure of the C-013-P (Cimino) group. Three bird watchers go to Humble Island every four to five days, depending on weather. We will continue weighing the chicks until they fledge. Currently, none have left the nest, but fledging should start happening any day now. The data collected is being sent to the Cimino group.

The Palmer Science Staff (Harpoon Seabring, Evan Quinter, and I) got the opportunity to participate in the NSF's Take Your Child to Work Day with a live Zoom call. The children had just finished an ice cream social and were ready to hear about the ultimate fun and cool thing, Antarctica. We explained what our jobs are, what a day consists of living and working on station, and how we got all the way to Antarctica by means of physical transportation and career paths. Their curious minds came up with a lot of situational and thoughtful questions.

The R/V Nathaniel B. Palmer made a three-day port call, departing Palmer Station on the May 2nd with the Denver Support Staff and the remaining summer ASC contractors aboard. Current station populations is 19 people ready for wintering in Antarctica at Palmer Station.

PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT
April 2024
Evan Quinter



Figure 1- Double Rainbow over Palmer Station, April 19th, 2024. *Image credit: Evan Quinter*

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

Andrew Gerrard, Principal Investigator, New Jersey Institute of Technology

Extremely Low Frequency/Very Low Frequency (ELF/VLF) radio wave observations at Palmer Station are used to provide a deeper understanding of lightning and its effects on the Earth's inner radiation belt. Lightning source currents are estimated or directly measured by experimental observations of individual natural and rocket-triggered lightning flashes in North America. Together, the North American and Antarctic data sets are used to experimentally identify and analyze the components of lightning and the effects of lightning, such as lightning-induced electron precipitation (LEP), that are observed in the Antarctic, more than 10,000 km away.

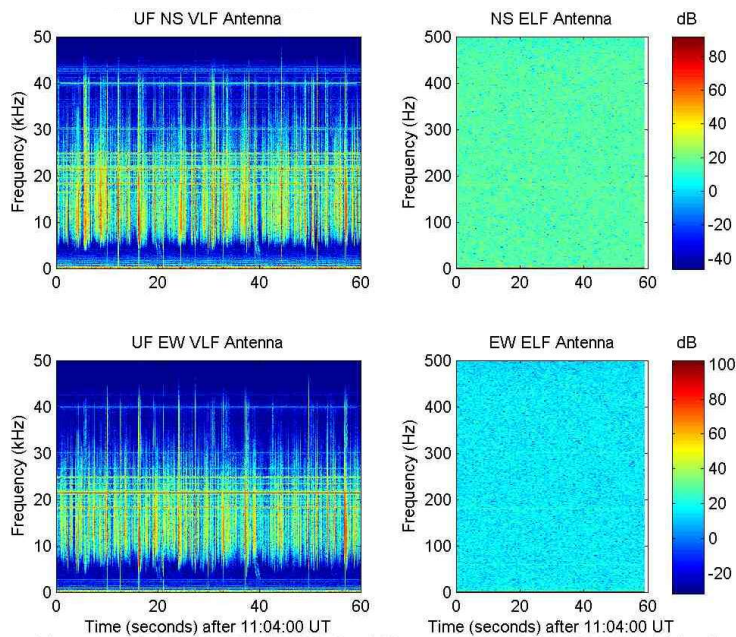


Figure 2. Real-Time broadband VLF and ELF Spectrogram from Palmer Station, Antarctica.

The new GPS receiver was installed on April 17th, and successfully established a GPS lock. However, the unit made an audible pop the next day around 2:30pm, which resulted in a loss of power in the unit's power supply. While the rest of the unit appears to be unharmed, the VLF/ELF radios are currently off while we work to repair the GPS unit. The bi-weekly antenna inspections continued as weather allowed.

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

Andrew Gerrard, Principal Investigator, New Jersey Institute of Technology

The three-axis fluxgate magnetometer at Palmer is one in a chain of eleven longitudinal, ground-based magnetometers extending down 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.

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

The magnetometer was originally installed at Palmer in 2005, and a replacement installed in April of 2008. In 2017 the project was taken over by Andrew Gerrard. A new Raspberry Pi system was installed in 2023. The system operated normally this month, only needing the live

plots to be reloaded once. More information can be found at:
<http://magnetometers.bc.edu/index.php/palmer>.

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

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

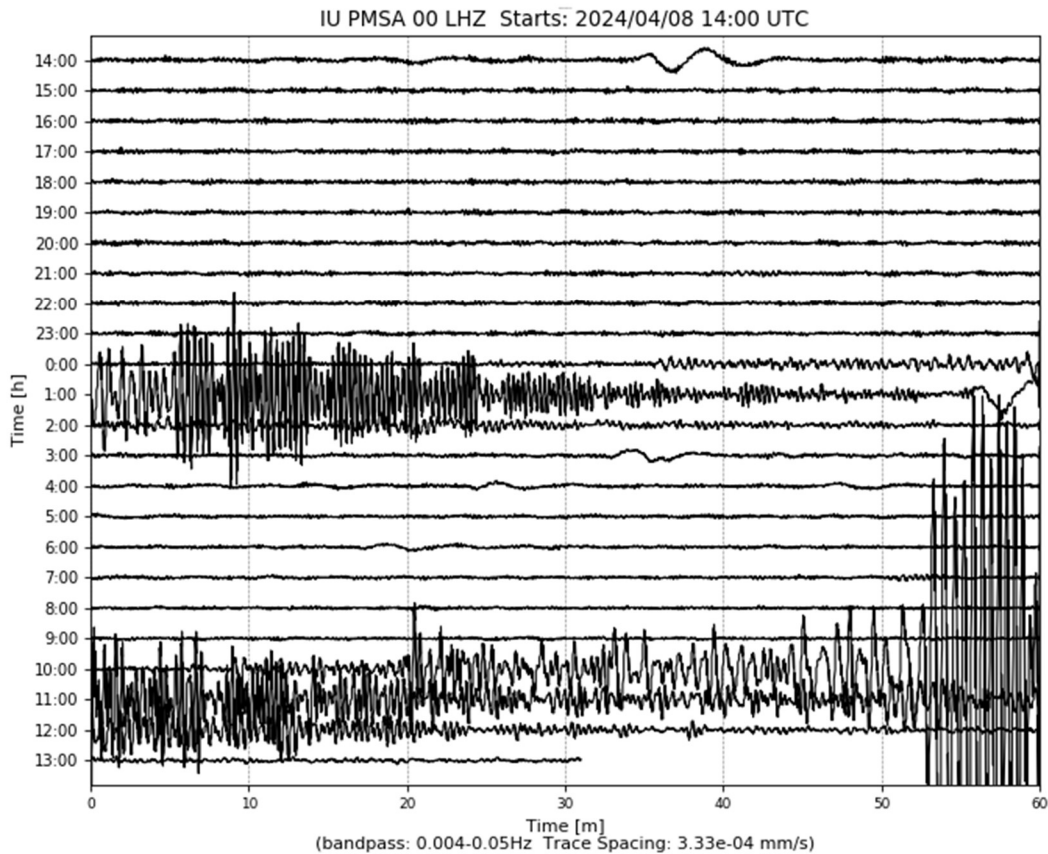


Figure 3. The April 9th 6.6 earthquake in the Molucca Sea, as recorded from the Palmer seismic station.

The system only experienced a brief network outage on April 18th, but otherwise performed normally. The time stamp and seismic activity found on the Heliplot was checked daily. Current data from Palmer station can be found on the USGS site:

<https://earthquake.usgs.gov/monitoring/operations/stations/IU/PMSA/#heliplot>.

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

Ralph Keeling, Principal Investigator, Scripps Institution of Oceanography

The goal of this project is to resolve seasonal and inter-annual variations in atmospheric O₂ (detected through changes in O₂/N₂ 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 CO₂ 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 O₂ 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 O₂ 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.

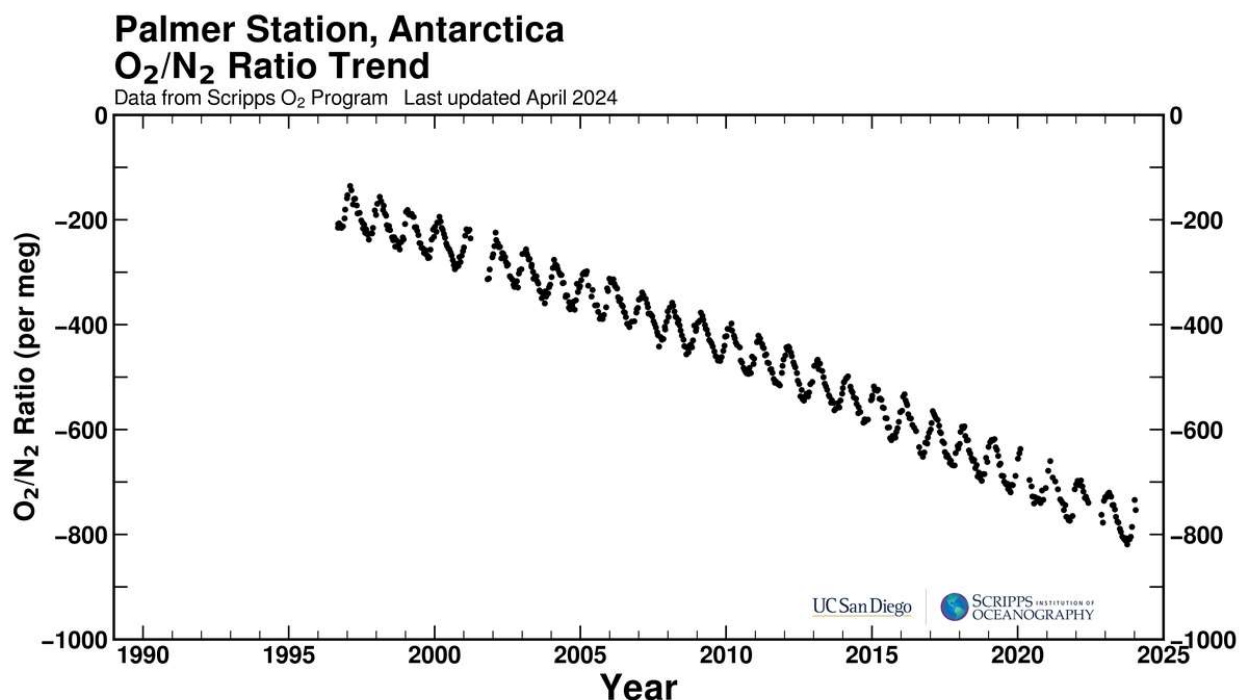


Figure 4. Historical plot of O₂/N₂ ratio per meg and CO₂ ppm updated April 2024.

Air samples were collected on April 3rd. Due to an unexpected shortage of flasks at station, sampling will move from biweekly to monthly. 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://scripps2.ucsd.edu/osub2sub-data.html>.

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

Don Neff and Steve Montzka, Principal Investigators, National Oceanic and Atmospheric Administration / Global Monitoring 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, April 8th, April 16th, April 23rd, and April 30th during favorable wind conditions. More information and data for the Carbon Cycle group can be found at: <https://gml.noaa.gov/ccgg/>.

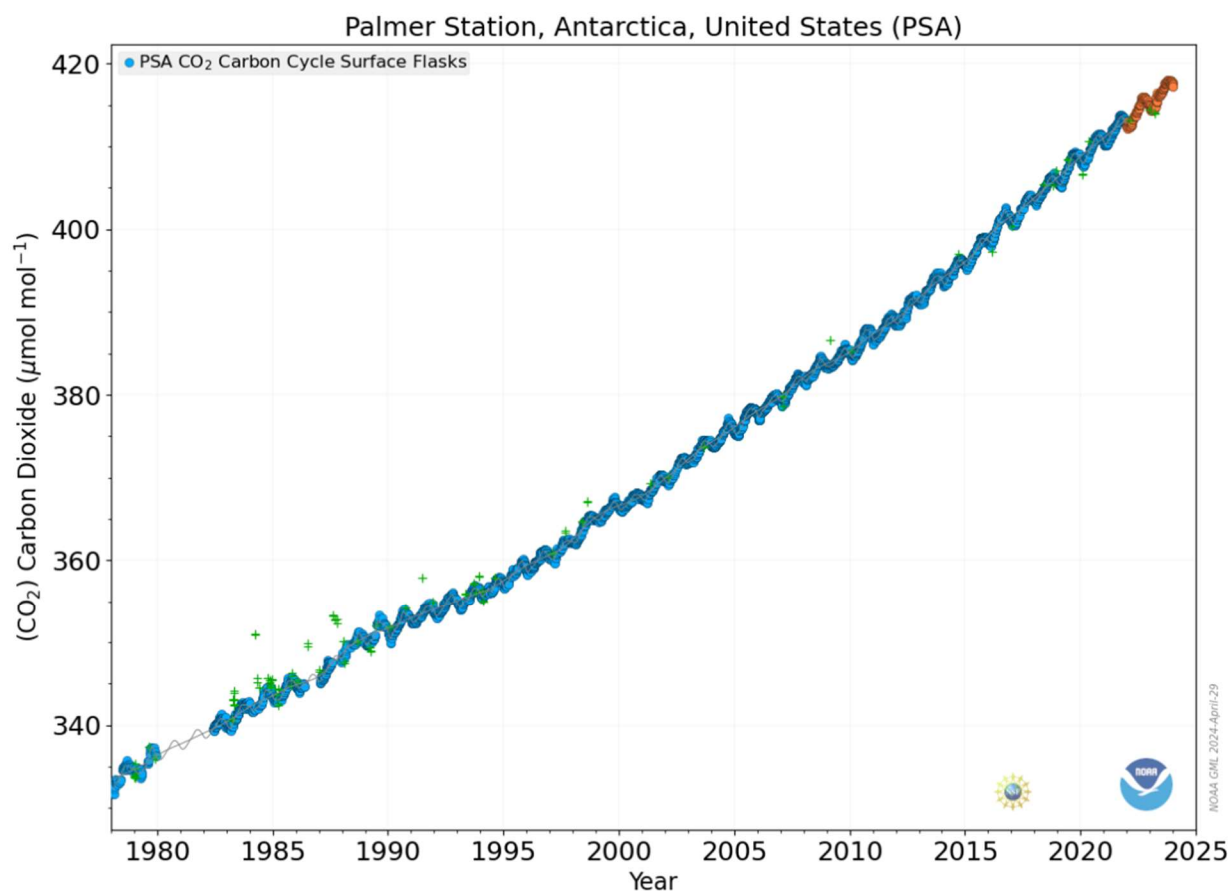


Figure 5. Carbon Dioxide (CO_2) levels at Palmer Station dating back to 1980. Orange dots are preliminary data and green pluses are poorly mixed air masses, which should not indicate background conditions.

HATS samples were collected on April 11th and April 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/>

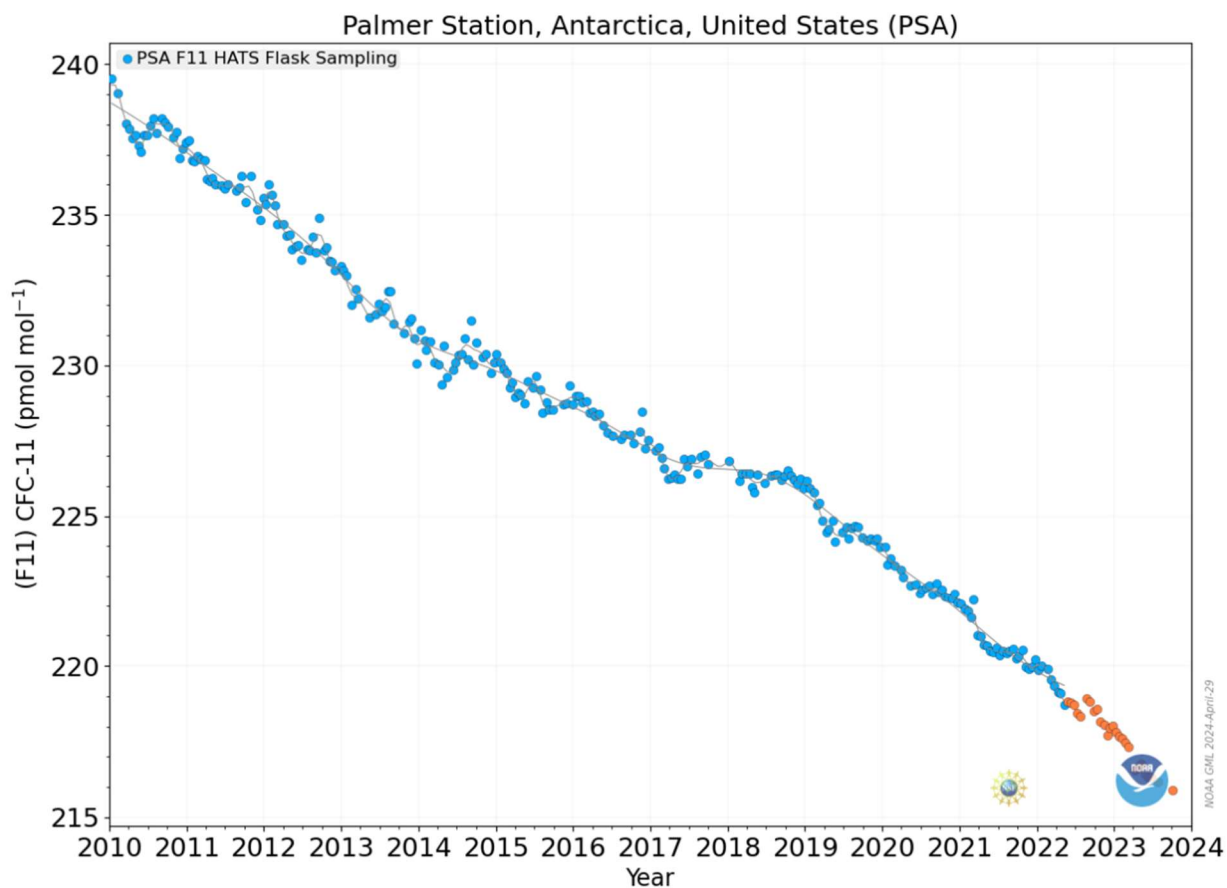


Figure 6. Chlorofluorocarbon-11 (CFC-11) levels at Palmer Station dating back to 2010, one of the Halocarbon and Trace Gases measured at Palmer Station. Orange dots are preliminary data.

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

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.

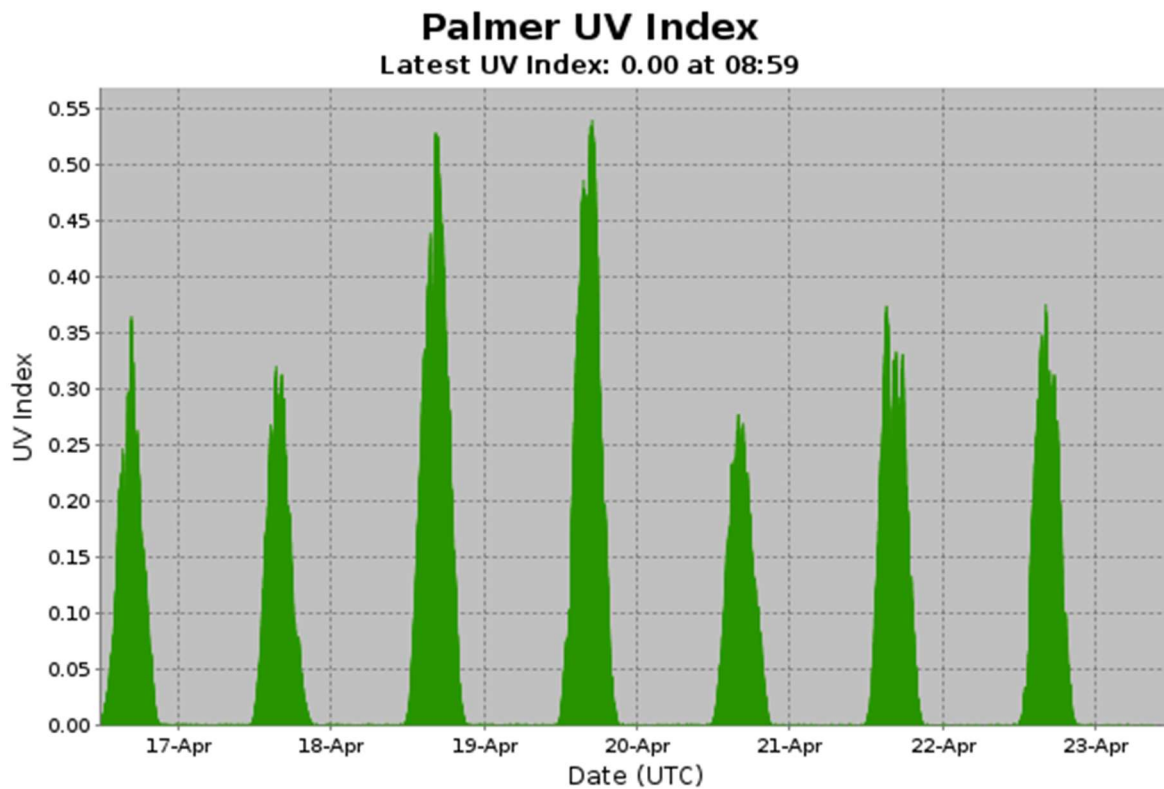


Figure 7. UV index generated from the GUV-511 radiometer in real time.

The log was filled out and collectors were cleaned on a daily basis. Once a week level checks were performed to confirm that the instrumentation was within +/- 0.2 degrees. The weekly log was sent out each Monday, and an SUV-100 Absolute Scan was performed on April 9th and April 23rd without issues. 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.

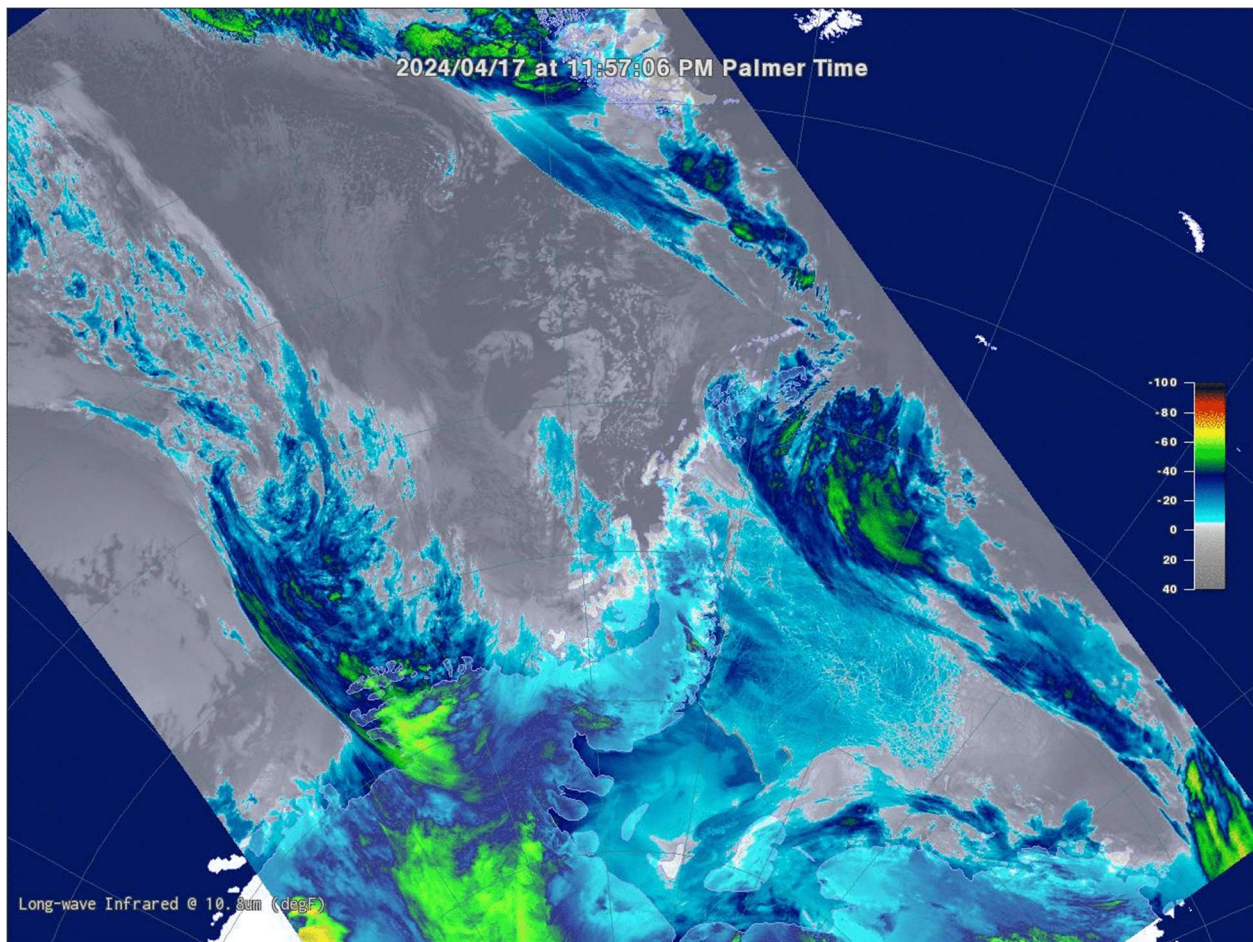


Figure 8. NOAA-19 April 17th satellite pass

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, UNAVCO

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

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

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

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

The system's new splitter was installed on April 15th and is successfully tracking satellites. We are currently working to ensure the real-time data is properly being transmitted and received.

The evolution of the glacier backyard terminus, profile and Point 8 terminus is below.

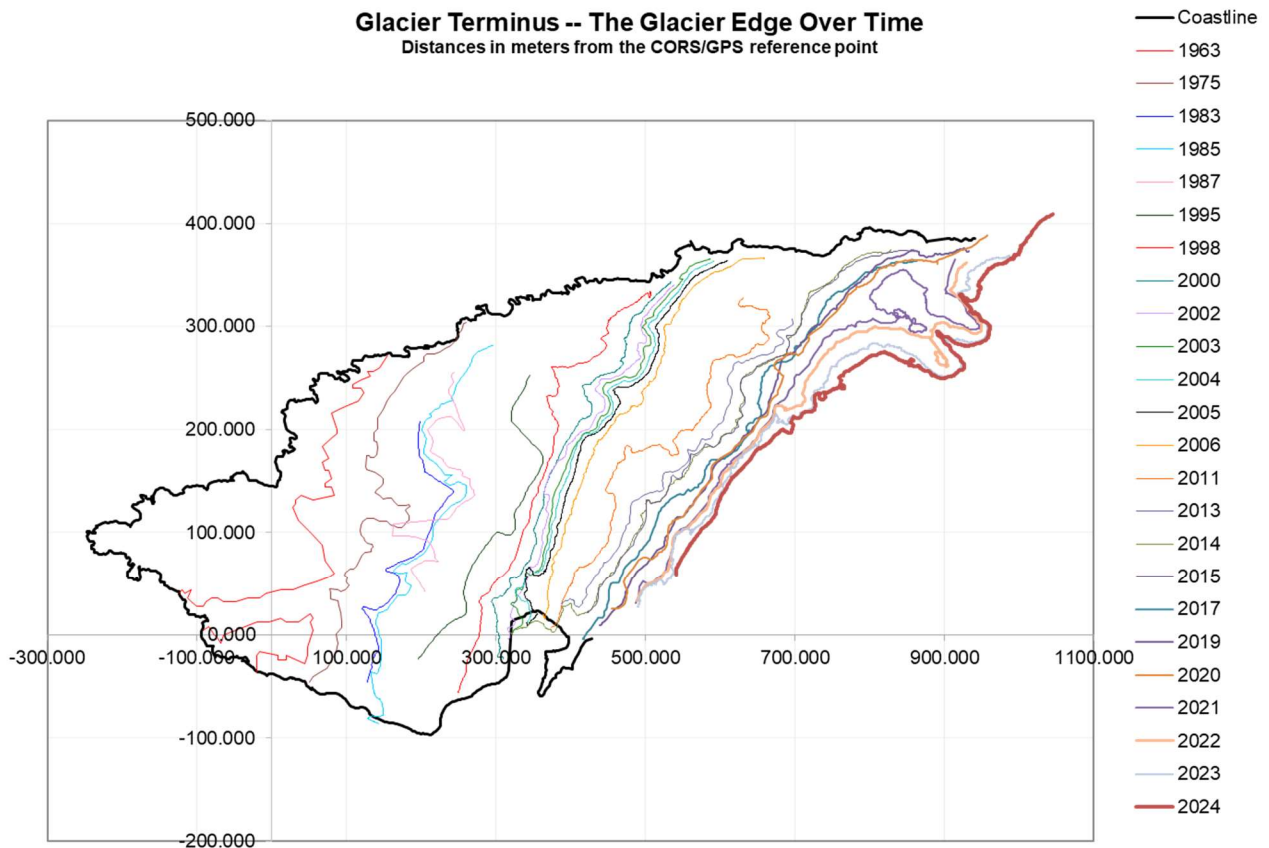


Figure 9: 61 Years of Glacier Retreat Data

For more information, visit: https://www.unavco.org/projects/project-support/polar/base_stations_and_survey_systems/palmer/base.html.

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

Managed by General Dynamics

The Comprehensive Nuclear Test Ban Treaty (CTBT) bans all nuclear explosions. Although not ratified, the U.S.A. is following through with the treaty, including the installation monitoring stations around the world. The global verification regime for monitoring compliance is called the International Monitoring System (IMS). The radionuclide air particulate sampling station was installed at Palmer in October of 2005. Palmer's radionuclide sampler/analyzer (RASA) is a

primary station in the IMS, known by its treaty code USP73 (and RN73). The pre-existing USGS seismic system is an auxiliary station, treaty code AS106.

Data collected by Palmer's RASA unit is relayed real-time via a virtual private network (VPN) across the Internet back to the CTBT Organization (CTBTO) in Vienna. As of August 2006, both the RASA and seismic systems have been certified by CTBTO. Palmer is now officially part of the IMS. The automated RASA continually filters ambient air and tests for particulates with radioisotope signatures indicative of a nuclear weapons test. The Research Associate operates and maintains the instrument.

The system operated consistently this month. The RASA GUI needed a restart, which was successfully restored the display. The amount of filter material was checked as needed, and the new flow meter continues to operate. Daily filters were processed as needed and the monthly log was sent on time.

Additional details about the treaty and monitoring stations can be found on the CTBTO 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.

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. The system operated normally this month. The tide gauge is set to be cleaned during the first week of May.

Tide level, sea water conductivity, and sea water temperature data is archived on the AMRC website: <http://amrc.ssec.wisc.edu/data/ftp/pub/palmer/>.

METEOROLOGY

Mike Carmody, Principal Investigator, United States Antarctic Program

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

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

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

One minute weather data is archived on the AMRC website:

<http://amrc.ssec.wisc.edu/data/ftp/pub/palmer/>.

Palmer Monthly Met summary for April, 2024 :

Temperature
Average: -1.2 °C / 29.9 °F
Maximum: 5.6 °C / 42.08 °F on 16 Apr 05:17
Minimum: -6.1 °C / 21.02 °F on 23 Apr 11:50
Air Pressure
Average: 978.2 mb
Maximum: 1000.4 mb on 12 Apr 19:24
Minimum: 947 mb on 6 Apr 03:53
Wind
Average: 14.1 knots / 16.3 mph
Peak (5 Sec Gust): 57 knots / 66 mph on 14 Apr 14:17 from NNE (31 deg)
Prevailing Direction for Month: SW
Surface
Total Rainfall: 74.4 mm / 2.93 in
Total Snowfall: 76 cm / 29.6 in
Greatest Depth at Snow Stake: 35.4 cm / 13.8 in
WMO Sea Ice Observation:
Average Sea Surface Temperature: -0.28 °C / 31.5 °F