

PALMER STATION MONTHLY SCIENCE REPORT

SEPTEMBER 2020



Photos from X-597-P (Crucian) time point sample collections. Clockwise, from the top right: Research Associate Lance Roth and Systems Administrator Tim Lynch (both members of the trauma team) receive blood draw training during one of the sample collections, a saliva tube sample, a health survey, and a HemoCue® finger stick sample being taken. *Image Credits: Hannah James*

NEWS FROM THE LAB

Hannah James, Winter Laboratory Supervisor

We've mentioned how much we've missed our grantees and all the marine life that have filled the aquarium in seasons' past, but have yet to highlight the project that has us winterovers as the specimens of interest. This season, the sixteen station members were offered a chance to participate in a NASA Human Research Program pilot case study. *Pilot assessment of stress and latent herpes virus reactivation at Palmer, Antarctica – Platform for validation of immune countermeasures?* (X-597-P) is led by Dr. Brian Crucian of NASA's Immunology Lab at the Johnson Space Center (JSC) in Houston, Texas. Immune system dysregulation is a large risk factor with astronauts, and Palmer Station may serve as a good ground base site to develop a worthy countermeasure for future long-duration space flight.

Throughout the season, those who have volunteered to participate are asked to fill out a survey answering questions about their general health and mental wellbeing, specifically the amount of stress they have been under, passively drool into a collection tube, allow the doctor to draw a small vial of venous blood, receive a finger-prick for on-site bloodwork, and provide a small hair sample. Through each of these specimens, immunologists back at JSC will measure leukocyte distribution, reduced cellular function, altered cytokine profiles, and stress hormone changes through five sample periods stretched over our winter season. These changes have been associated with a number of negative health events during astronauts' time in space. Palmer has a small enough population and 'normal' atmospheric living conditions (as opposed to the

South Pole, which is a hypoxic environment due to its elevation) that may be the perfect fit to study how stress, circadian disruption, isolation, and confinement affect one's immune system.

With the return of the sun and the clearing of the sea ice, wildlife sightings have increased immensely in the past month. Giant Petrels, Kelp Gulls, Cormorants, and Antarctic Terns are seen by the dozen (or sometimes hundreds, in the case of Antarctic Terns). During the final week of September, Gentoo and Adélie penguins started returning to the area with sightings on and around Janus, Humble, and Torgersen Islands. Elephant seals were seen ashore on Bonaparte Point, fur seals have been seen on islands and swimming around the harbor, a few leopard seal sightings happened throughout the month, and two female Weddell seals hauled out on Hero Inlet sea ice to give birth to two seal pups. It is clear to the winter crew why so many of these islands are now closed to general visitors! The lack of sea ice also allowed a group to travel out to the Joubins to troubleshoot a weather station- details can be found below in the meteorology section.

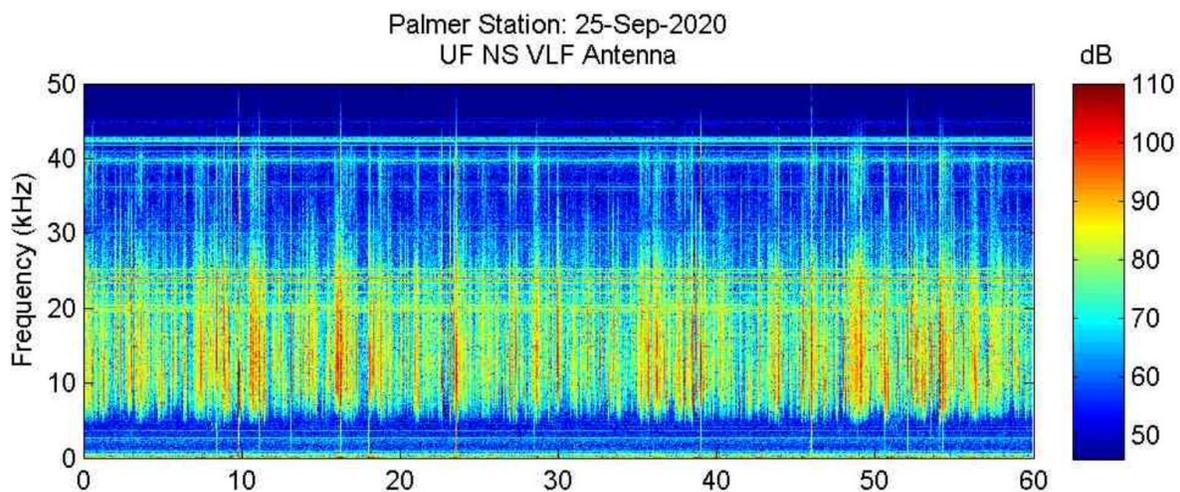
**PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT
September 2020**

Lance Roth

**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.



Real-Time broadband ELF/VLF Spectrogram from Palmer, Antarctica

Both the Extremely Low Frequency and Very Low Frequency systems had issues with the Data Acquisition software this month. The issues were resolved remotely by researchers at the University of Florida. The spectrograms were reviewed daily and bi-weekly antennas inspections were done as weather allowed. Current VLF/ELF data from Palmer Station can be observed at: http://halo.ece.ufl.edu/realtime_palmer_nb.php and http://halo.ece.ufl.edu/realtime_palmer_bb.php.

A-111-P: SAMBA MAGNETOMETER

Andrew Gerrard, Principal Investigator, New Jersey Institute of Technology

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

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

The magnetometer was originally installed at Palmer in 2005, and a replacement installed in April of 2008. In 2017 the project was taken over by Andrew Gerrard. On February 27th 2017 the USAP IT blocked all northbound VPN traffic under a larger umbrella of blocking all northbound encrypted-tunnel traffic. Since that time there has been much discussion, but the magnetometer is still a security vulnerability. The Research Associate has been working with the home institution at the University of California, Los Angeles to resolve this issue. Instructions from the ASC Palmer Science Manager and NSF are for the RA to “keep the system running” but not to make any updates or spend significant time on the project. As of September 30th at 7:45am local time, the magnetometer is no longer on the network. The instrumentation and computer are still operational. Data will continue to be collected, but will be stored locally for the unforeseeable future or until the storage is full. More information can be found at: <http://magnetometers.bc.edu/index.php/palmer>.

B-005-P: COASTAL OCEAN DYNAMICS APPLICATIONS RADAR (CODAR)

Josh Kohut, Principal Investigator, Rutgers University Department of Marine

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

The system operated consistently throughout the month. The computer at the Wauwerman site went down in April, however the Joubins and Palmer sites are still generating data. Data will be available in the future at: <https://marine.rutgers.edu/~codaradm/>.

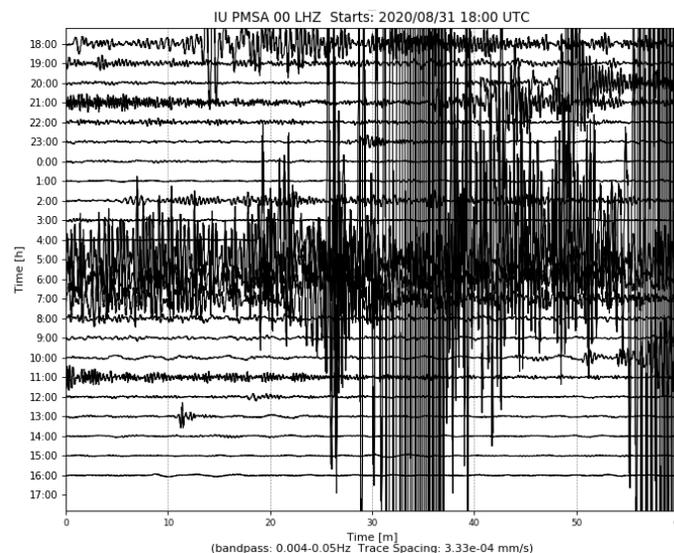
G-090-P: GLOBAL SEISMOGRAPH NETWORK (GSN) SITE AT PALMER STATION.
Kent Anderson, Principal Investigator, Incorporated Research Institutions for Seismology (IRIS)

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

A standard seismic station consists of three seismometers oriented to detect ground motion along three mutually perpendicular lines. Most of the time the directions chosen are north-south, east-west, and up-down. The seismometers in the Palmer Station installation are “forced balanced” instruments, which means that they work by keeping an inertial mass stationary with respect to the instrument (and the earth). When a seismic wave arrives, the ground moves, carrying along the housing of the seismometer. The inertial mass tends to remain stationary and not move with the instrument, but it is electronically “forced” to travel along with the instrument (and the earth). The amount of “force” necessary to make it move with the rest of the instrument is proportional to the ground acceleration and is recorded as the raw data from the seismometer.

By examining time of arrival, azimuth, magnitude, frequency and wave type of the incoming waves, seismologists can determine the location, depth of focus, magnitude, type of faulting that occurred, ground acceleration in gravitational force and the structure of the medium (the earth) through which the waves traveled to reach the station. The Research Associate operates and maintains on-site equipment for the project.

Heliplot



Heliplot of the 5.4 magnitude earthquake in the South Shetland Islands on September 1, 2020

The system operated consistently throughout the month. The time stamp and seismic activity found on the Heliplot was checked daily. Current data from Palmer station can be found on the USGS site: <https://earthquake.usgs.gov/monitoring/operations/stations/IU/PMSA/#heliplot>.

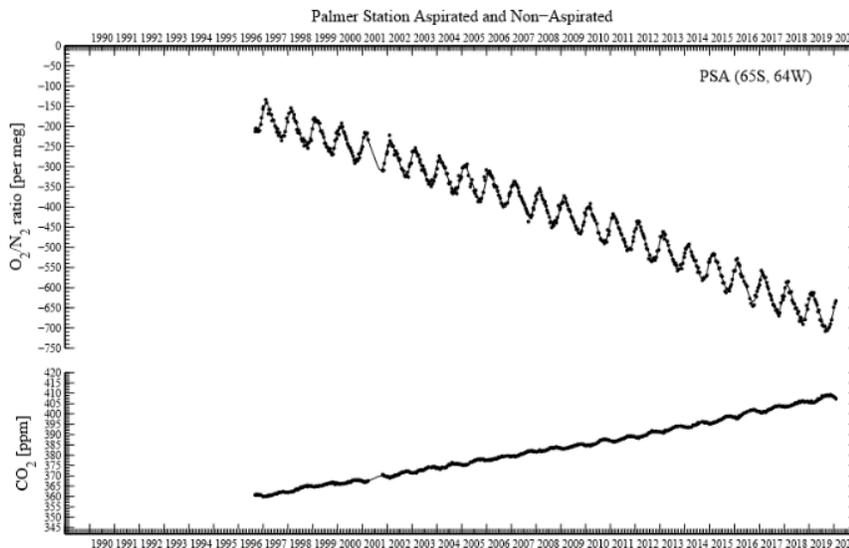
O-264-P: A STUDY OF ATMOSPHERIC OXYGEN VARIABILITY IN RELATION TO ANNUAL DECADAL VARIATIONS IN TERRESTRIAL AND MARINE ECOSYSTEMS.

Ralph Keeling, Principal Investigator, Scripps Institution of Oceanography

The goal of this project is to resolve seasonal and inter-annual variations in atmospheric 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 process, 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.



Historical plot of O₂/N₂ ratio per meg and CO₂ ppm updated on July 29, 2020

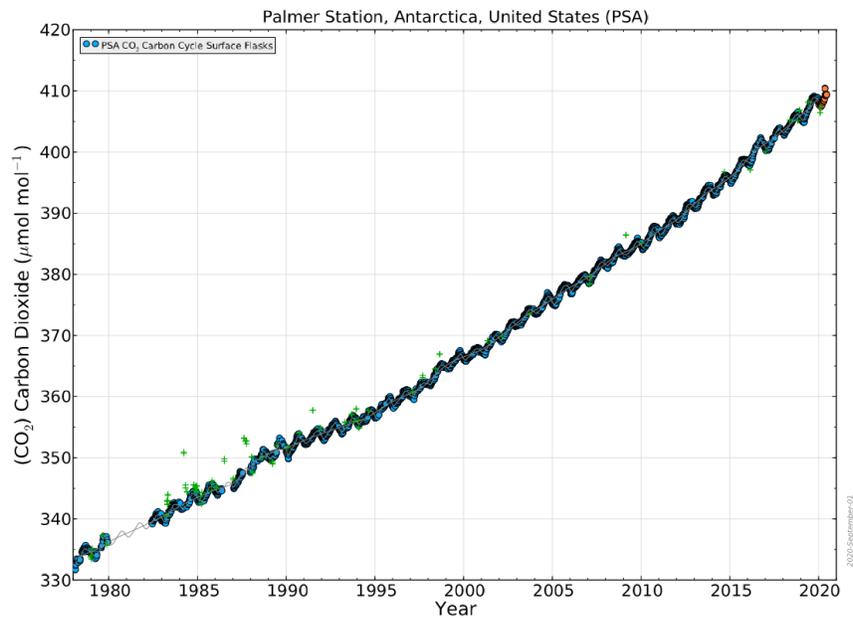
Air samples were taken on September 10th at 11:40am local time and September 17th at 11:20am local time. Wind conditions must equal or exceed 5 knots from a direction between 5° to 205° constantly for over an hour. These air samples will be shipped to Scripps Institution of Oceanography in California 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 Division; Boulder, CO

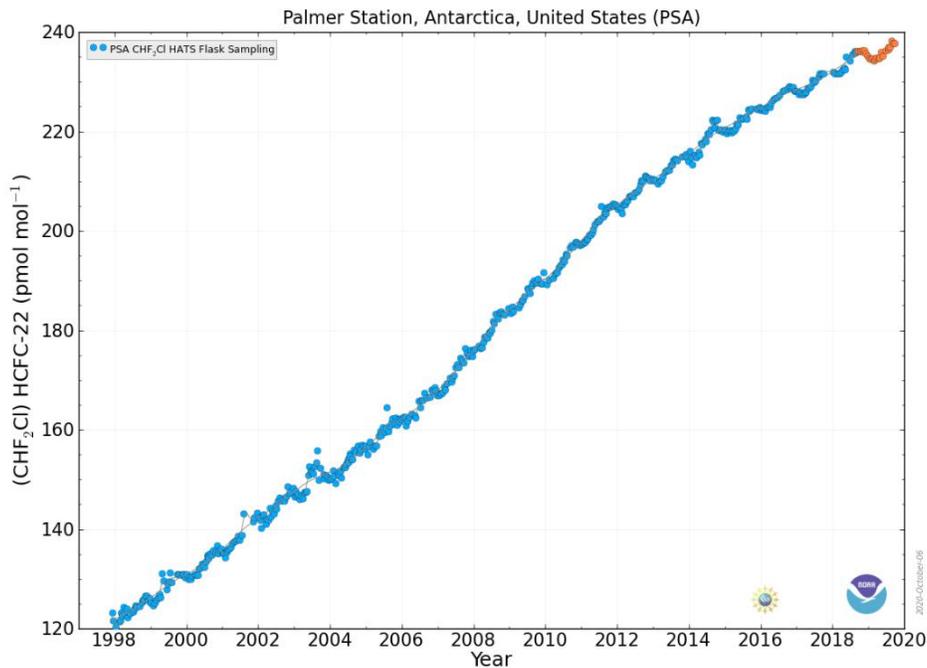
The NOAA ESRL Carbon Cycle Greenhouse Gases (CCGG) group makes ongoing discrete measurements to document the spatial and temporal distributions of carbon-cycle gases and provide essential constraints to our understanding of the global carbon cycle. The Halocarbons and other Atmospheric Trace Species (HATS) group quantifies the distributions and magnitudes of the sources and sinks for atmospheric nitrous oxide (N₂O) and halogen containing compounds. The Research Associate collects weekly air samples for the CCGG group and fortnightly samples for the HATS group.

Carbon Cycle Greenhouse Gases (CCGG) samples were taken on September 3rd at 8:24am local time, September 12th at 9:13pm local time, September 17th at 10:38am local time, September 24th at 10:31am local time, and September 30th at 9:19am local time during favorable wind conditions. More information and data for the Carbon Cycle group can be found at: <https://www.esrl.noaa.gov/gmd/ccgg/trends/>.



Historical CO₂ Levels at Palmer Station dating back to 1978. Orange dots are preliminary data.

The Halocarbons and other Atmospheric Trace Species (HATS) samples were taken on September 13th at 9:17am local time, and September 24th at 11:17am local time while wind conditions allowed. You can visit <https://www.esrl.noaa.gov/gmd/hats/> for more information about the Halocarbons and other Atmospheric Trace Species group.



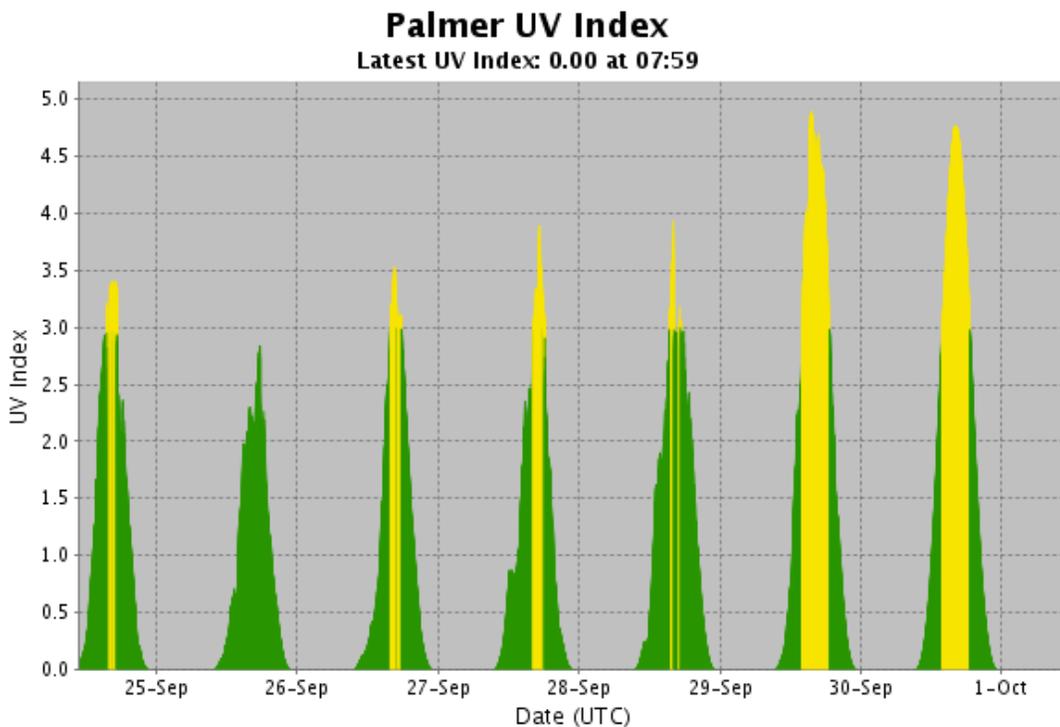
Historical measurements of HCFC-22, one of the Halocarbon and Trace Gases measured at Palmer Station. Orange dots are preliminary data.

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 Division; Boulder, CO

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



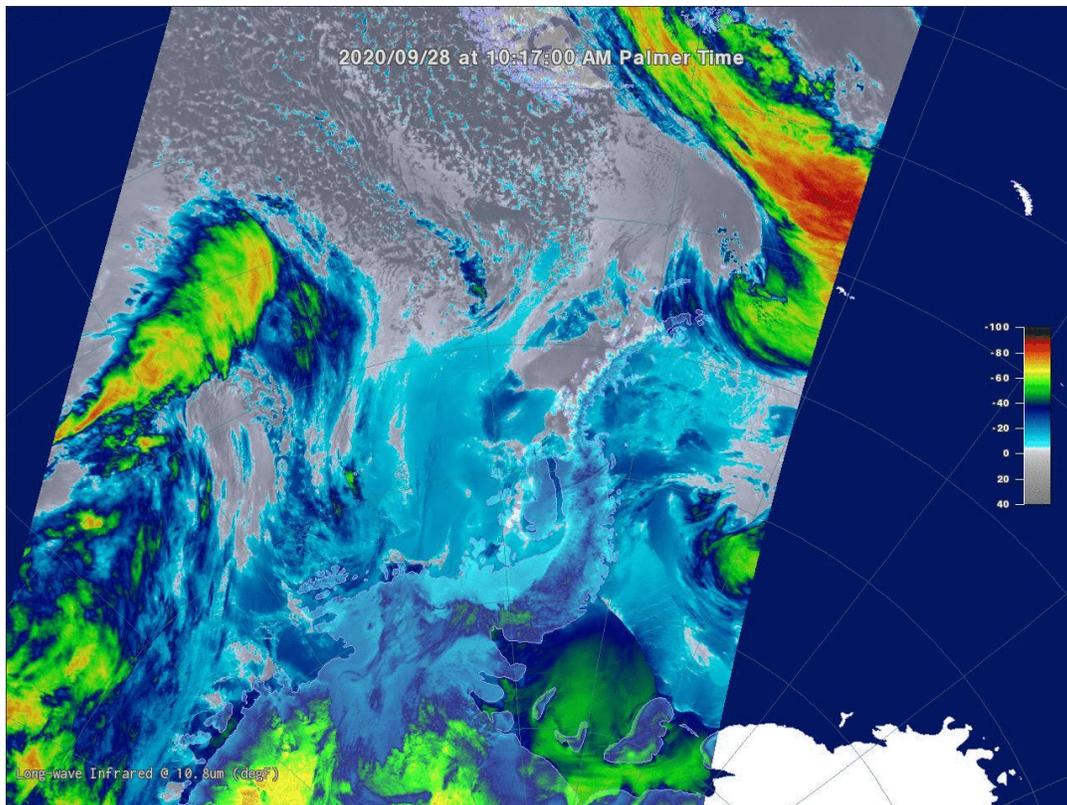
UV index generated from the GUV-511 radiometer in real time

The system is having issues with the wavelength offset on the SUV-100 UV spectroradiometer. The Principal Investigator is aware of the issue and has provided a procedure to follow when this occurs. 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 a bi-weekly SUV-100 UV absolute scan was performed on September 9th and September 22nd as scheduled 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.



NOAA-18 satellite pass from September 28th at 10:17am local time

The imagery was checked daily. Data from the NOAA satellites looks normal, while the data from the DMSP drops out. The TeraScan team is aware of the excessive noise, missing data, and anomalies of the DMSP passes and are trying to resolve the issue.

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 training and support to visiting grantees at his/her discretion.

The system operated consistently throughout the month. The lights on the Trimble, Javad, and Ashtech Receivers were all illuminated and showed no signs of interruption. More information can be found at the following website: https://www.unavco.org/projects/project-support/polar/base_stations_and_survey_systems/palmer/base.html.

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

The Comprehensive Nuclear Test Ban Treaty (CTBT) bans all nuclear explosions. Although not ratified, the U.S.A. is following through with the treaty, including the installation monitoring stations around the world. The global verification regime for monitoring compliance is called the International Monitoring System (IMS). The radionuclide air particulate sampling station was installed at Palmer in October of 2005. Palmer's radionuclide sampler/analyzer (RASA) is a primary station in the IMS, known by its treaty code USP73 (and RN73). The pre-existing USGS seismic system is an auxiliary station, treaty code AS106.

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

The system operated consistently this month. The RASA GUI was checked daily. The amount of filter material was checked as needed and no anomalies were heard coming from the blower. On September 28th the UPS was checked, the timing bar sensor was cleaned, the drive rollers were inspected, and grease was applied to the lead screw on the QC motor. Daily filters were processed and the monthly log was sent as needed. Additional details about the treaty and monitoring stations can be found on the CTBTO web site, <http://ctbto.org/>.

PHYSICAL OCEANOGRAPHY

Palmer Station has a tide and conductivity gauge located on the pier at -64.774563° -64.054837° at a height of (base datum) 12.13 meter. It was installed in 2018 as the previous location was not adequate for tide or temperature measurements.

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 tide data was monitored continuously. Sea ice imagery was sent to the Nathaniel B. Palmer. Tide data is archived on the AMRC website: <ftp://amrc.ssec.wisc.edu/pub/palmer/tidegauge/>.

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. This location better represents the wind by eliminating wind shadows such as the Bio Building and the ARSV *Laurence M. Gould* when it is at the pier. Also, the sensors aren't affected by the sea salt spray, which was a problem in the past. 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.

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

The local weather station (PAWS) operated well throughout the month. Clear and sunny days allowed the remote weather stations to wake up intermittently and provide data. A site visit to the Joubins was made on September 28th to replace the battery and fix the temperature/humidity sensor. One minute weather data is archived on the AMRC website: <ftp://amrc.ssec.wisc.edu/pub/palmer/observations/>.

SEPTEMBER 2020 WEATHER

Lance Roth, Research Associate

Temperature
Average: -4.5 °C / 23.8 °F
Maximum: 2.8 °C / 37.04 °F on 10 Sep 22:30
Minimum: -14.6 °C / 5.72 °F on 1 Sep 23:08
Air Pressure
Average: 982.5 mb
Maximum: 1011.5 mb on 4 Sep 05:30
Minimum: 932.5 mb on 15 Sep 00:15
Wind
Average: 10.1 knots / 11.6 mph
Peak (5 Sec Gust): 67 knots / 77 mph on 14 Sep 07:38 from NE (42 deg.)
Prevailing Direction for Month: NNE
Surface
Total Rainfall: 40.4 mm / 1.59 in
Total Snowfall: 46 cm / 17.9 in
Greatest Depth at Snow Stake: 94 cm / 36.7 in
WMO Sea Ice Observation: 6-10 Bergs, bergy bits, growlers, brash, grease ice, and ice rind
Average Sea Surface Temperature: -1.63 °C / 29.1 °F

September started out cold as the minimum ambient air temperature dropped down to 5.72°F on the 1st. Sea surface temperatures dropped down to 28.8°F creating young ice (gray, gray-white ice), 10-30 cm thick out beyond the two mile boating limit. The ice remained until September 13th when temperatures and wind began to increase. The ambient air temperature reached a high of 37°F on September 10th and winds peaked on September 14th with gusts over 75 mph. Average sea surface temperature continued to remain below freezing at 29.1°F but after the 13th of September, most of the ice was of land origin in the form of bergs, growlers, and brash ice. The average ambient air temperature for the month was also below freezing at 23.8°F while the average wind speed was a modest 11.6 mph. A total of 17.9 inches of snow accumulated during several warm fronts, raising our total snow accumulation to 36.7 inches. The Spring Equinox on September 22nd was very apparent as the daylight hours increased along with the UV index.



Palmer Station web camera September 2, 2020



Palmer Station web camera September 30, 2020