PALMER STATION MONTHLY SCIENCE REPORT

NOVEMBER 2020

Life is abundant at Palmer station these days- both flora and fauna are seen all around station. Clockwise, from the top right: Adélie penguins nesting on Torgersen Island (Mike Rice photo), Gentoo Penguins at Point 8, grass recently exposed by melting snow (Hannah James photos), and a Chinstrap penguin (Mike Rice photo).

NEWS FROM THE LAB

Hannah James, Winter Laboratory Supervisor

With the abundance of wildlife sightings, long, sunny days, and open water it is safe to say that summer has arrived at Palmer Station. At the time of writing this report, the *R/V Laurence M Gould* is docked at the pier and turnover from the winter to the summer crew is underway, and the four Long Term Ecological Research scientists are working on getting their lab spaces set up and seasons started.

With the improved weather, many outdoor projects were completed in preparation of station opening. The Penguin Cam was fixed (photos are uploaded every 15 seconds during daylight hours at Palmer Penguin Cam - Live, so the world is welcome to check on the Adélie colonies as their eggs hatch in the near future. The floating dock was put in the water on November 24 and boats were moved around in the Palmer Yard in preparation for the return of the Marine Landing Craft and *RHIB Hadar* on LMG20-03. The Gentoo colony discussed in the previous report has substantially dwindled, as it seems most of the pairs left Point 8 to nest elsewhere. A few nests and pairs remain, but estimates are in the dozens rather than the previously seen hundreds. The big wildlife excitement came on November 16 when two humpback whales were spotted from station surfacing near Janus Island. Since then, multiple sightings have occurred both from land and small boat operations on the water.

Since this will be my final report of the season, I would like to extend a thank you to the entire Palmer Station community for an excellent winter season, with a special thank you to our supervisor Jamee Johnson, the Peninsula S&TPS Manager, and Lance Roth, the winter Research

Associate. Although it was a quiet year in BioLab, Terra Lab continued to produce some excellent datasets. With the vacant lab spaces in BioLab, many long term projects were able to be completed. And of course, it was wonderful to hear from the handful of grantees through our remote science lectures!

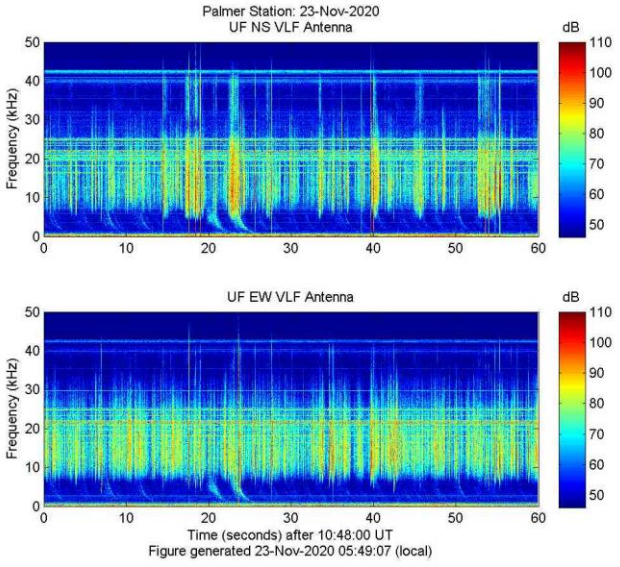
With that, I would like to welcome Randy Jones and Marissa Goerke back to station for another productive summer season, as well as the four LTER grantees: Megan and Darren Roberts representing C-013 (Cimino) and C-024 (Friedlaender), Rachael Young representing C-019 (Schofield), and Dan Lowenstein representing C-045 (Van Mooy). Although it is a late start and a less populated summer season, we are thrilled to have more grantees back on station doing what we all work to support here.

PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT
November 2020
W. 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, Antartcica

Both the Extremely Low Frequency and Very Low Frequency systems operated well this month. 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. As of September 30th at 7:45am local time, the magnetometer was removed the network. The instrumentation and computer are still operational. Data will continue to be collected and stored locally. The RA is working with the IT department to send out the data to UCLA. 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.

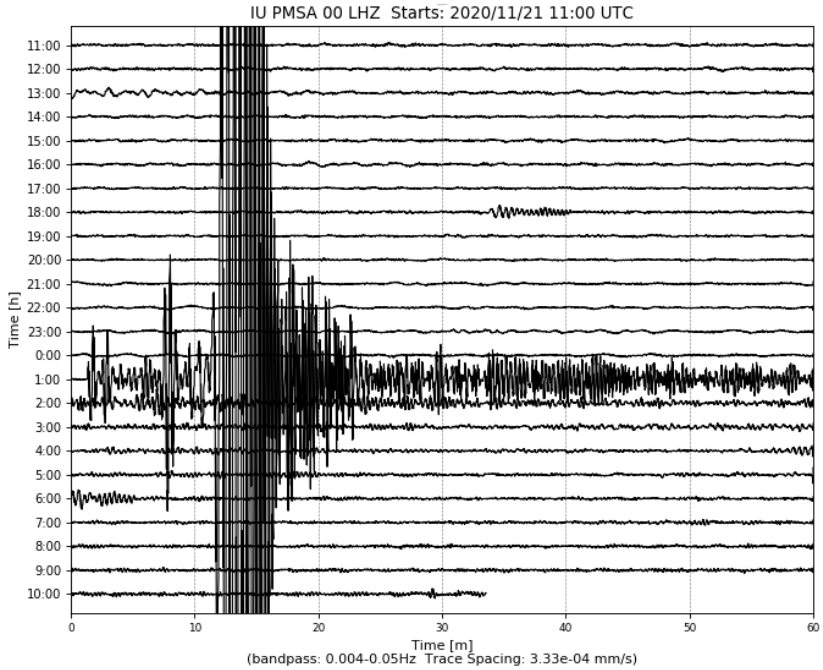
The system was not fully operational this month. The computers at the Wauwermans and Joubin sites are not sending data. Site visits have been requested by the Principal Investigator to troubleshoot possible problems. The visits have been delayed until we have favorable weather and more resources on station. 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.



6.2 Magnitude earthquakes off the coast of Libertador O'Higgins, Chile November 22nd, 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.

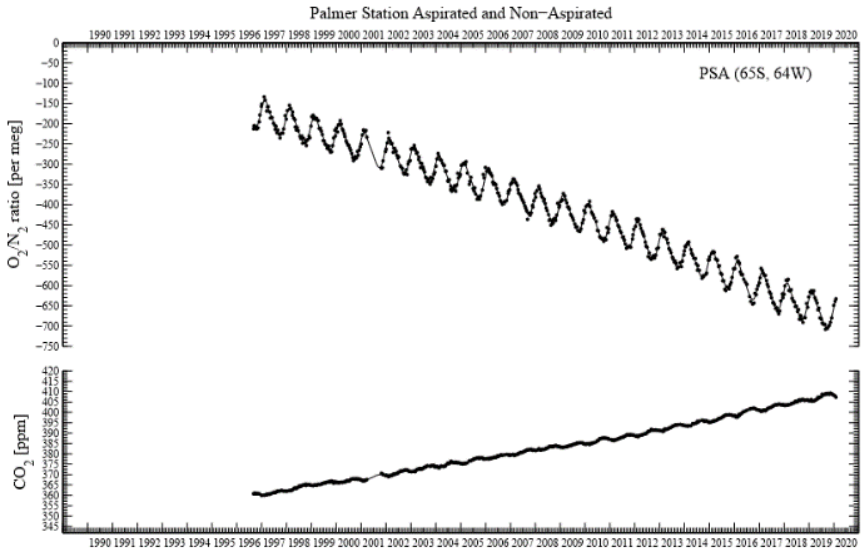
O-264-P: A STUDY OF ATMOSPHERIC OXYGEN VARIABILITY IN RELATION TO ANNUAL DECADAL VARIATIONS IN TERRESTRIAL AND MARINE ECOSYSTEMS.

Ralph Keeling, Principal Investigator, Scripps Institution of Oceanography

The goal of this project is to resolve seasonal and inter-annual variations in atmospheric 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 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 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. Due to a lack of inventory, the RA has been instructed by the Principal Investigator to only sample once a month starting in December using only two flasks instead of the trio.



Historical plot of O_2/N_2 ratio per meg and CO_2 ppm updated on July 29, 2020

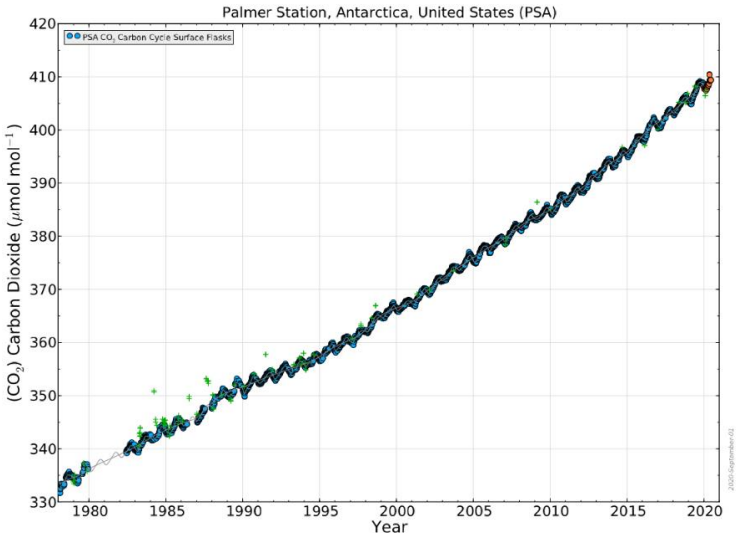
Air samples were collected on November 1st at 4:20pm local time and November 16th at 10:20am local time. Wind conditions must equal or exceed 5 knots from a direction between 5° to 205° constantly for over an hour. Due to a lack of resources the grantee has asked for a single sample on or near the 15th of each month using 2 flasks, beginning in December. These air samples will be shipped to Scripps Institution of Oceanography in California for analysis. More information and data can be found at: https://scrippso2.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

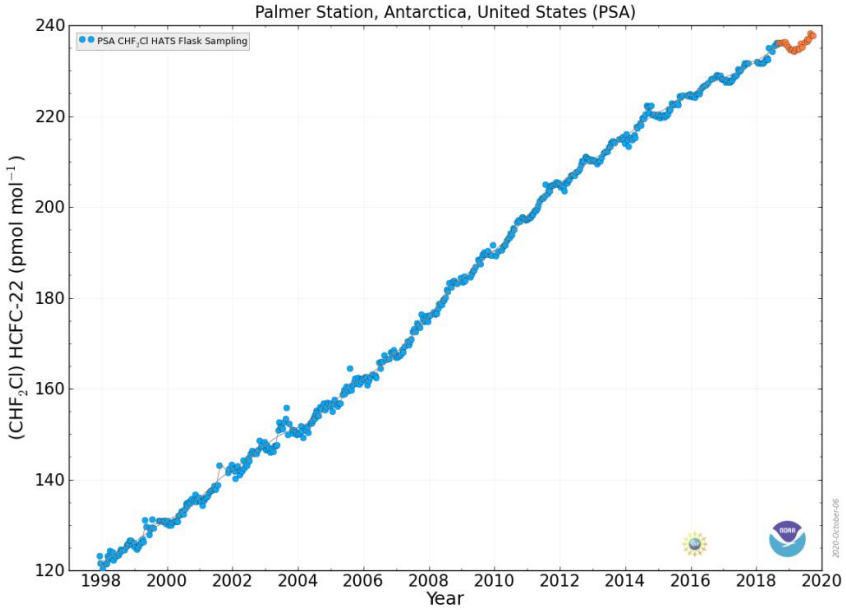
The NOAA ESRL Carbon Cycle Greenhouse Gases (CCGG) group makes ongoing discrete measurements to document the spatial and temporal distributions of carbon-cycle gases and provide essential constraints to our understanding of the global carbon cycle. The Halocarbons and other Atmospheric Trace Species (HATS) group quantifies the distributions and magnitudes of the sources and sinks for atmospheric nitrous oxide (N_2O) 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 collected on November 1st at 10:31am local time, November 8th at 7:57am local time, November 14th at 8:19am local time, November 21st at 3:42pm local time, and November 26th at 9:26pm 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 CO_2 Levels at Palmer Station dating back to 1978. Orange dots are preliminary data.

The Halocarbons and other Atmospheric Trace Species (HATS) samples were collected on November 9th at 3:54pm local time, and November 24th at 10:17pm local time during favorable wind conditions. You can visit https://www.esrl.noaa.gov/gmd/hats/ for more information about the Halocarbons and other Atmospheric Trace Species group.

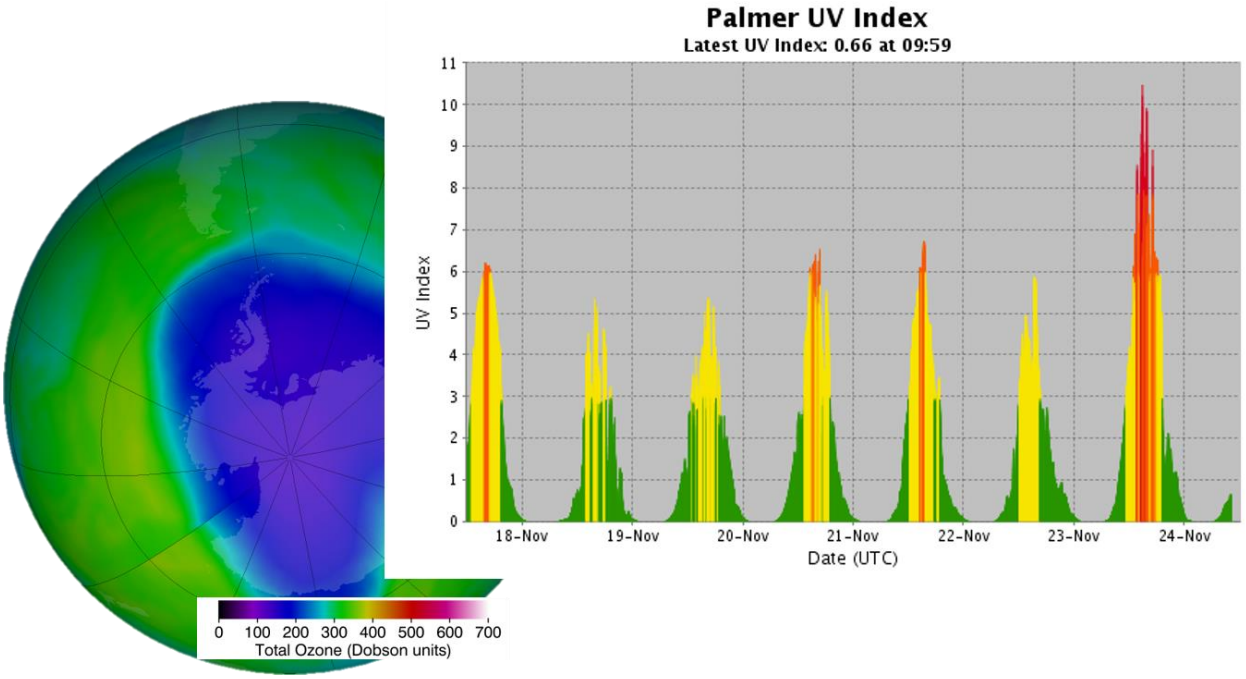


Historical measurements of HCFC-22, one of the Halocarbon and Trace Gases measured at Palmer Station. Orange dots are preliminary data.

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.



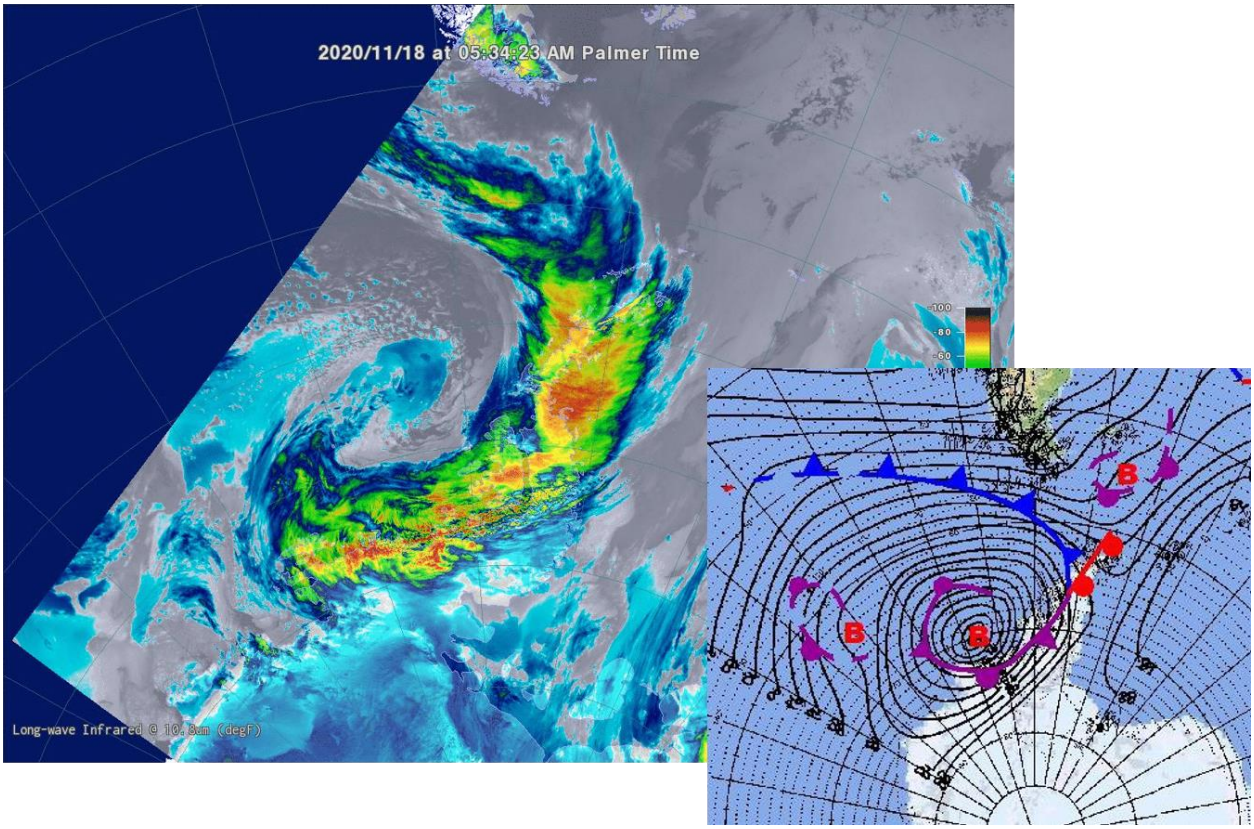
NASA image of the Ozone Hole over the Palmer Penisula on November 23rd and the UV index generated from the GUV-511 radiometer in real time.

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. There was a power issue that was traced back to the Power Strip and resolved, but issues continue with the Power Supply, specifically with the bridge rectifier on the circuit board. 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 November 8th and November 17th 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 November 18th with the triple point of an occluded front passing Palmer Station.

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.

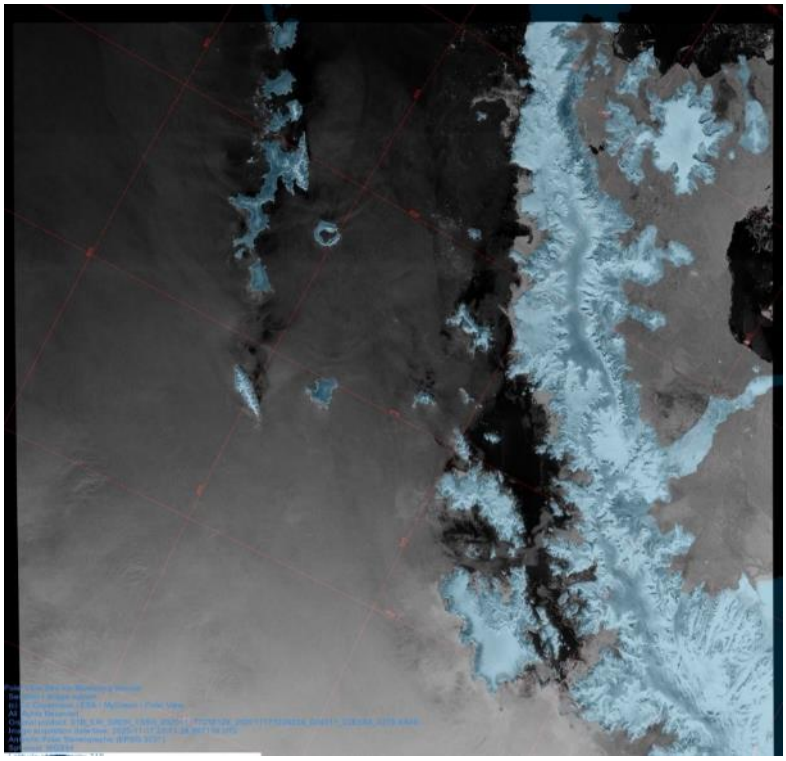
The system operated consistently this month. The RASA GUI was checked daily. The amount of filter material was checked as needed and no anomalies were heard coming from the blower. Daily filters were processed and the monthly log was sent as needed. Filters were divided up quarterly into individual boxes and are ready for shipment north. A software upgrade was done on the 30th. 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. Local sea ice imagery was redistributed to the *R/V Laurence M. Gould*. Sea ice imagery of the Weddell Sea was also redistributed daily to the *RVIB Nathaniel B. Palmer*. The tide data was monitored continuously. Tide data is archived on the AMRC website: ftp://amrc.ssec.wisc.edu/pub/palmer/tidegauge/.



Sentinel-1 Satellite image of the sea ice around Anvers Island and James Ross Island November 17, 2020

METEOROLOGY

Mike Carmody, Principal Investigator, United States Antarctic Program

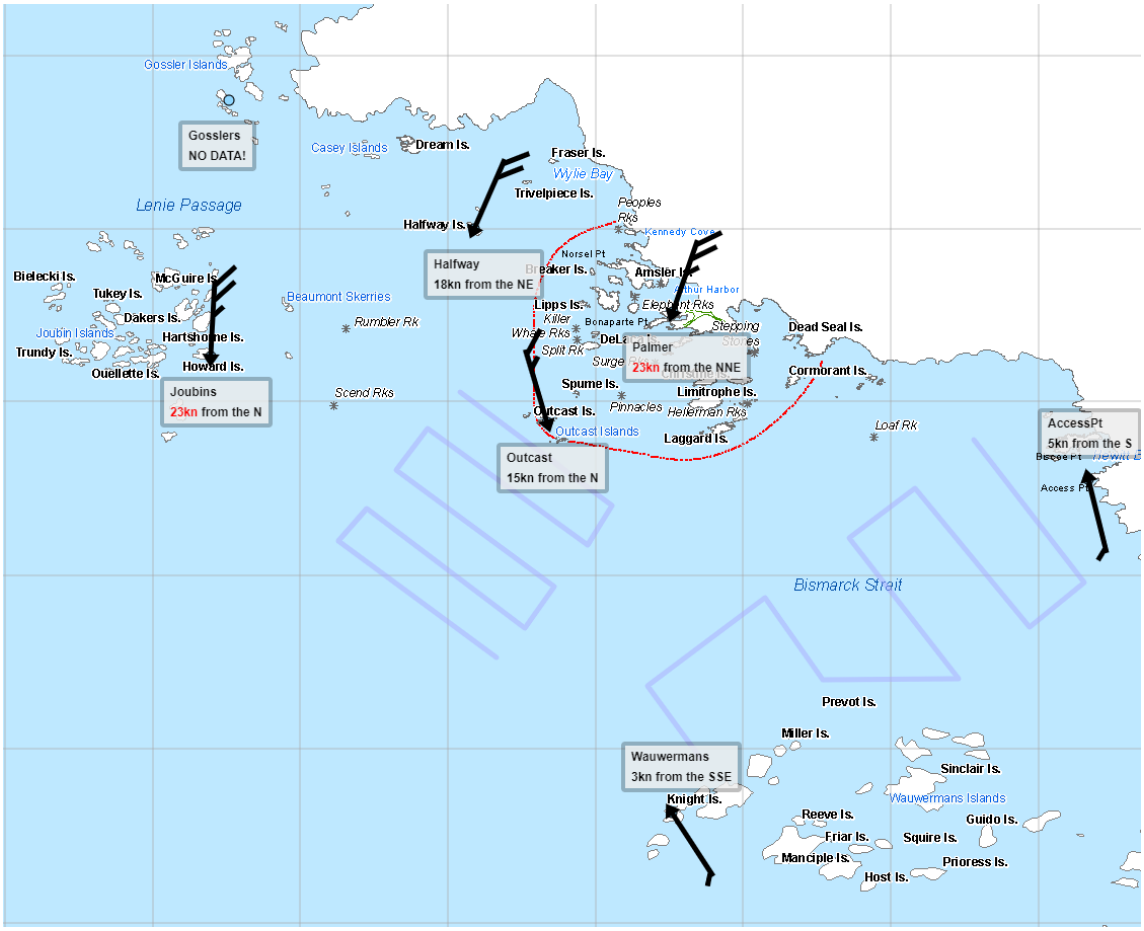
Palmer Station is Station 89061 in the World Meteorological Organization (WMO) Worldwide Network. Automated surface synoptic observations are made 8 times each day and emailed to the National Atmospheric and Oceanographic Administration (NOAA) for entry into the Global Telecommunication System (GTS).

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 once per month to the University of Wisconsin on the first day of each month for archiving and further distribution.

The local weather station (PAWS) operated well throughout the month. There is an issue with AWS3 at the Gosslers that will need to be addressed during a site visit. AWS1 has been having an issue with its temperature sensor. This will also need to be addressed during the next site visit. One minute weather data is archived on the AMRC website: ftp://amrc.ssec.wisc.edu/pub/palmer/observations/.



Palmer Station AWS map on November 23th, 2020.

Palmer Monthly Met summary for November, 2020

Temperature
Average: 0.3°C / 32.5°F
Maximum: 7.2°C / 44.96°F on 2 Nov 00:55
Minimum: -3.5°C / 25.7°F on 9 Nov 09:45
Air Pressure
Average: 977.5 mb
Maximum: 1008.4 mb on 1 Nov 06:21
Minimum: 952.1 mb on 30 Nov 15:03
Wind
Average: 15.9 knots / 18.3 mph
Peak (5 Sec Gust): 61 knots / 70 mph on 2 Nov 22:19 from NNW (342 deg.)
Prevailing Direction for Month: NNE
Surface
Total Rainfall: 135.9 mm / 5.35 in
Total Snowfall: 36 cm / 14 in
Greatest Depth at Snow Stake: 103.4 cm / 40.3 in
WMO Sea Ice Observation: 1-6 icebergs with growlers and bergy bits
Average Sea Surface Temperature: -0.99°C / 30.2°F

An occluded front passed over Palmer Station on November 2nd causing the temperature to climb to 45°F, winds to peak at 70mph, and over 2.7 inches of rain to fall. These warm occluded fronts continued to pass over the peninsula all month bringing our average ambient air temperature to 32.5°F. The combination of the warm temperatures, 5.35 total inches of rain, and the large ozone hole over the peninsula has diminished our snowpack to 27 inches, despite the occasional snow flurry. On November 23rd our UV index peaked at 10.5. The ozone hole continued to grow, stretching all the way to South America on November 28th. The average sea surface temperature was 30.2°F preventing sea ice to form near station, however southerly winds and incoming tidal events would transport icebergs, bergy bits, growlers, and brash ice into the local boating area.