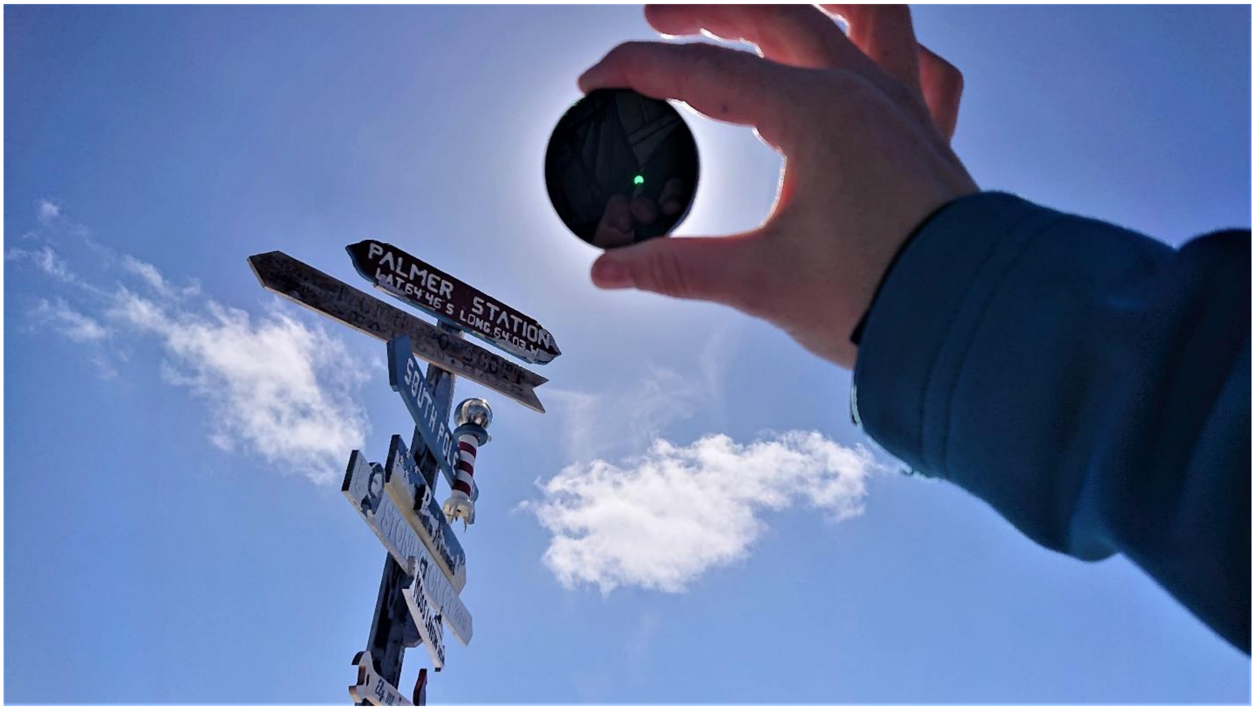
PALMER STATION MONTHLY SCIENCE REPORT

DECEMBER 2020



Partial solar eclipse on 14 December 2020. *Image Credit: Marissa Goerke*

NEWS FROM THE LAB
Randy Jones, Summer Laboratory Supervisor

After the pandemic-induced delay to our arrival at Palmer Station, it was quite a different experience to take in the scene at Palmer upon arrival – the arrival was essentially ice-free and snow cover on the local islands and around station was melting ahead of schedule regarding brash/sea ice cover and snow depth. The winter and summer science crews had substantial overlap with the three-week port call, which allowed us to complete a considerable list of tasks, while supporting the grantee groups. The predator field team, C-013-P, was able to get out on the day of our arrival, thanks to the support of the winter SAR teams. The LTER water column field teams (C-019-P and C-045-P) have been patient as trainings are completed, and the RHIBs are brought online and troubleshot. They were able to complete some modified sampling from the seawater pumphouse and from the Zodiacs at Station E and in the vicinity of Palmer.

We were treated in the middle of a bustling port call to a partial solar eclipse. Summer Research Associate, Marissa Goerke, setup an eclipse viewing station and we were able to view the eclipse, which occurred for about 1:45 (hr:min) with an occlusion of about 23.5%. A photo above, by Marissa Goerke, shows the eclipse above the Palmer Station sign at approximately the time of maximum occlusion.

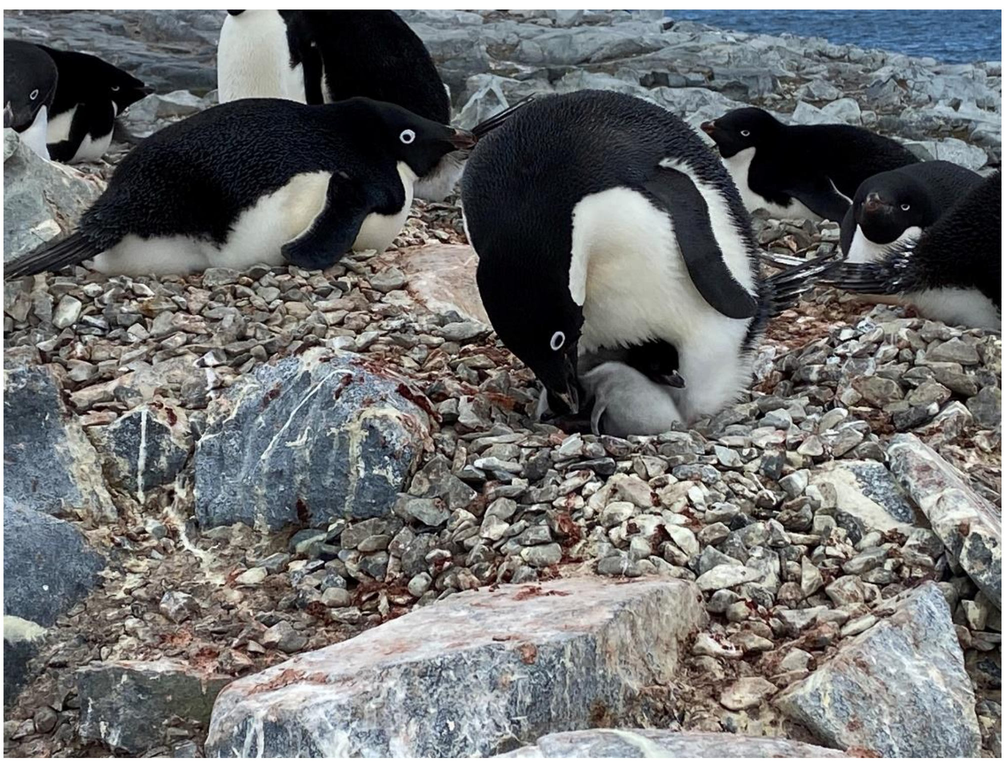
Many thanks to our winter counterparts – Hannah James, Winter Laboratory Supervisor, and Lance Roth, Winter Research Associate, for their support of science during these past months. Their hard work and efforts are greatly appreciated!

C-013-P and C-024-P: PALMER, ANTARCTICA LONG TERM ECOLOGICAL RESEARCH (LTER): LAND-SHELF-OCEAN CONNECTIVITY, ECOSYSTEM RESILIENCE, AND TRANSFORMATION IN A SEA-ICE INFLUENCED PELAGIC ECOSYSTEM – APEX PREDATOR COMPONENT

Personnel on station: Darren Roberts and Megan Roberts

Following a substantial quarantine period, the LTER predator field team was very grateful to begin field operations in early December. With the aid of the ASC winter and summer crews, we were able to begin field work on 4 December, our first day on station. The winter and summer station managers were instrumental in making this happen, and we are very appreciative. Thankfully we got to the colonies before any Adélie penguin chicks had hatched. This allowed us to set up our reproduction study in time to record true hatch dates for all of the nesting birds involved in that study.

Weather conditions allowed for boat based field work on 26 of the 28 days we were present on station this month. Following the establishment of the reproduction study, we continued daily monitoring of nesting Adélie penguins on Humble and Torgersen throughout the month. Additionally we completed full censuses of all Adélie penguin colonies in the local group. Full censuses of Gentoo and Adélie penguins were completed at Biscoe Island, and at Dream Island the same counts of Adélie and Chinstrap penguins were completed.



Newly hatched Adélie penguin chicks. *Image Credit: Cimino group*

The largest Adélie penguin colony on Humble Island during full island counts. *Image Credit: Cimino group*

Preparations for the Adélie penguin presence/absence study were completed in December, with a radio receiver installed at Humble Island. Radio receiver data collection and transfer was tested, in the office and after installation at Humble. Final testing of satellite telemetry, and time depth recorders was completed. The IT department was vital in helping us with the ever changing landscape of tagging software, and we thank them for their constant support. The Adélie penguin foraging component began in late December with the deployment of the first satellite and time depth recording tags on Humble and Torgersen.

The brown skua mark-recapture and breeding study began this month as we began checking nests for newly hatched chicks on local islands as well as on Dream and Biscoe Islands. Our south polar skua mark-recapture and breeding study on Shortcut Island began with nest initiation checks and band recording. Our census of the blue-eyed shag colony on Cormorant Island began with chicks observed in early December. A gull survey was completed at all local kelp gull colonies as well.

Deployment of a satellite telemetry tag on a southern giant petrel at Elephant Rocks. *Image Credit: Cimino group*

Our all-island census of southern giant petrel nests was started in December. Breeding pairs were identified and new breeders were banded. The giant petrel foraging ecology study began with satellite transmitter deployments at Elephant Rocks. Additionally our very first camera tag was deployed on a giant petrel to further understand feeding behavior.

Due to the reduced level of science personnel on station, the predator field teams, C-013-P and C-024-P, are collaborating in order to maintain continuous data collection for both projects. In terms of whales, the unique nature of the season provides an extremely rare and novel opportunity. Namely, this may be the only season where there is essentially no cruise ship presence on the western Antarctic Peninsula. Our collaboration will allow C-024-P to not only continue the standard LTER sampling to some degree, but to also get some insight into stress hormone levels in whales that are undisturbed by cruise ship excursions. Biopsy sampling began towards the end of December and will continue throughout the season.

C-019-P: PALMER, ANTARCTICA LONG TERM ECOLOGICAL RESEARCH (LTER): LAND-SHELF-OCEAN CONNECTIVITY, ECOSYSTEM RESILIENCE, AND TRANSFORMATION IN A SEA-ICE INFLUENCED PELAGIC ECOSYSTEM – PHYTOPLANKTON COMPONENT

Dr. Oscar Schofield, Principal Investigator, Rutgers University, Institute for Earth, Ocean, and Atmospheric Sciences, Department of Marine and Coastal Sciences

Personnel on station: Rachael Young

Despite current global challenges, the C-019-P (Schofield) lab is grateful and excited to return to Palmer Station for its 13th season studying phytoplankton as part of the LTER project. Phytoplankton play an essential role in forming the basis of the food web and providing energy to all other higher trophic level species. With a reduced population on station due to the COVID-19 pandemic, each science group has only one representative. For the Schofield team, Rachael Young, a research technician from Rutgers University, is thrilled to be back in Antarctica for her second summer to discover the crucial connections between phytoplankton and the biophysical variables in the water. To form a clearer picture of the water column, the Schofield lab will be collaborating closely with the C-045-P group, represented by Daniel Lowenstein. Lowenstein is a research technician from Woods Hole Oceanographic Institution studying chemical energy cycling and microbial community biomarkers. After additional precautionary measures of quarantine and COVID-19 tests, the ARSV *Laurence M. Gould* arrived at Palmer Station in early December. Once the lab and field equipment were prepped, LTER sampling began on 19 December.

Since 1991, the 30-year-old LTER dataset has continued to record the changes in phytoplankton community composition over time. To capture the seasonal and interannual variability in phytoplankton, C-019-P collects water samples and biological and physical parameters using a variety of techniques. On 19 and 21 December, Station E was sampled at seven different depths from 0-65m. In a typical LTER sampling day, an optical instrument known as a C-OPS radiometer is deployed to measure the light profile of the water column, and a CTD rosette is deployed to gather salinity, temperature, density, turbidity, and fluorescence (Fig. 1). Water samples are processed for phytoplankton abundance (Figs. 2 and 3), size, species, and photosynthetic efficiency using fluorometry, HPLC analysis, FIRe fluorometry, and an Imaging Flow Cytobot (IFCB).

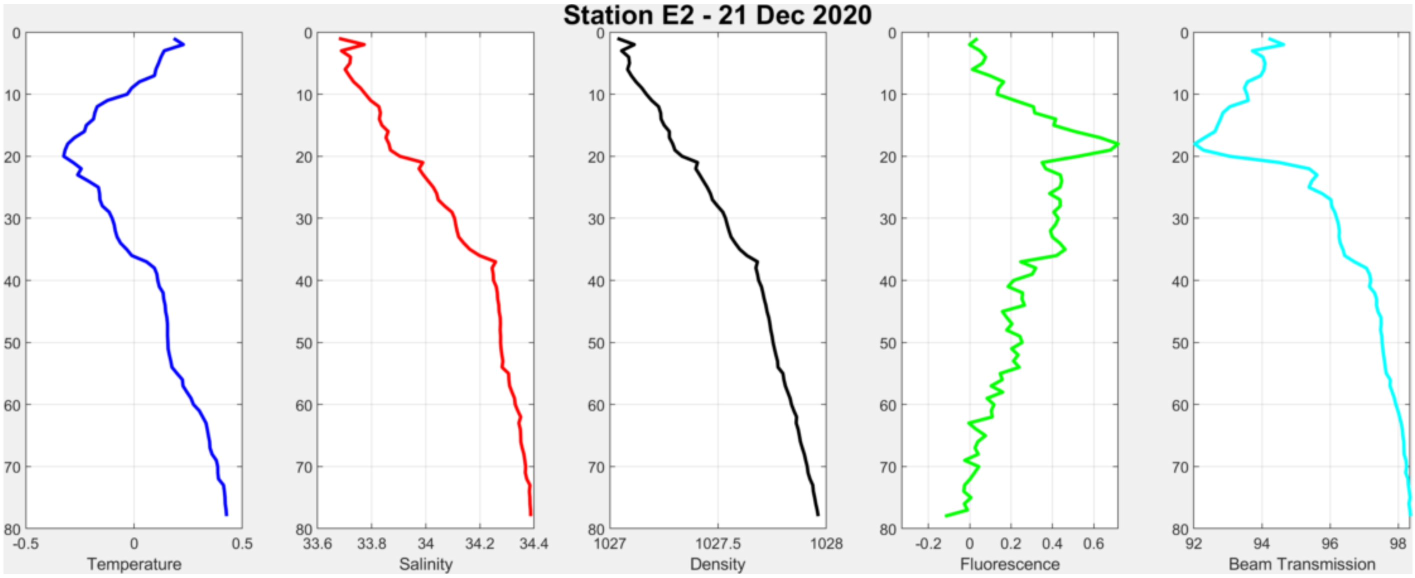


Fig. 1 – CTD data at Station E on 21 December 2020 displaying temperature (°C), salinity (ppt), density (kg m^{-3}), and fluorescence (mg m^{-3}) profiles against depth in meters.

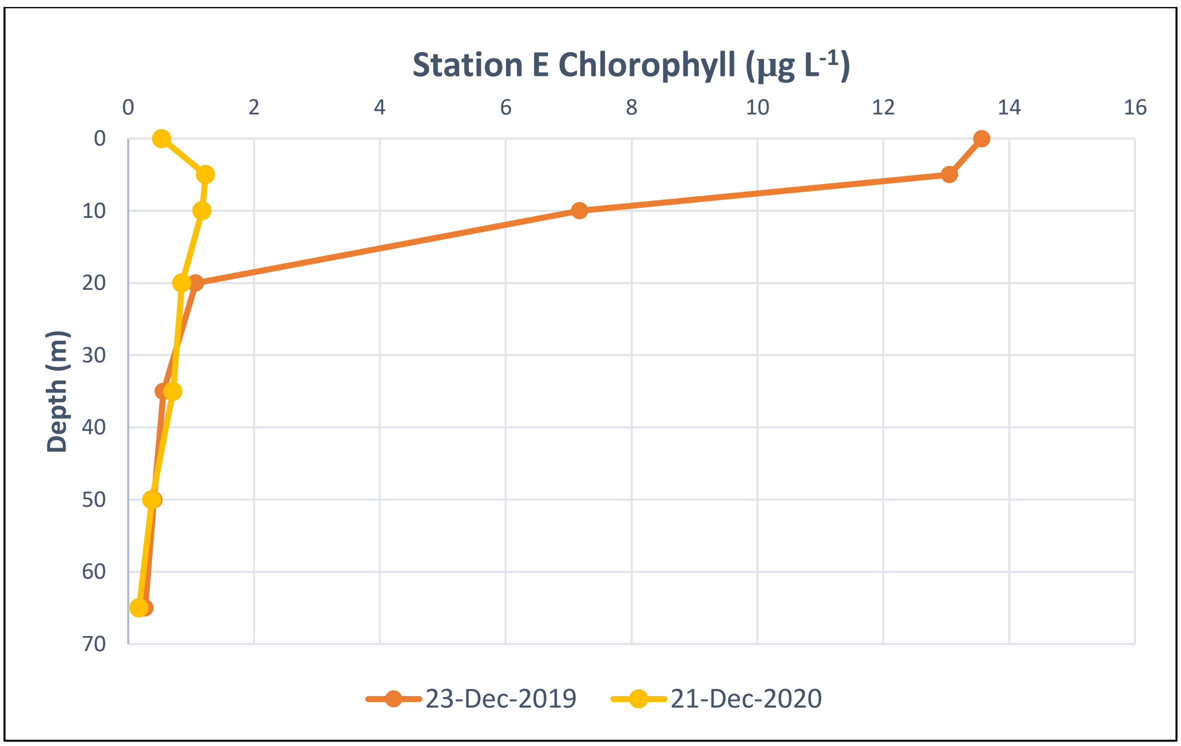


Fig. 2 – Chlorophyll (ug L^{-1}) from Station E in December 2019 (orange line) and December 2020 (yellow line). In December 2019, the 23rd is representative of a peak phytoplankton bloom, while 21 December 2020 shows a relatively mixed water column without a bloom present. (See also, Autofluorescent phytoplankton cell counts in Fig. 7, C-045-P report).

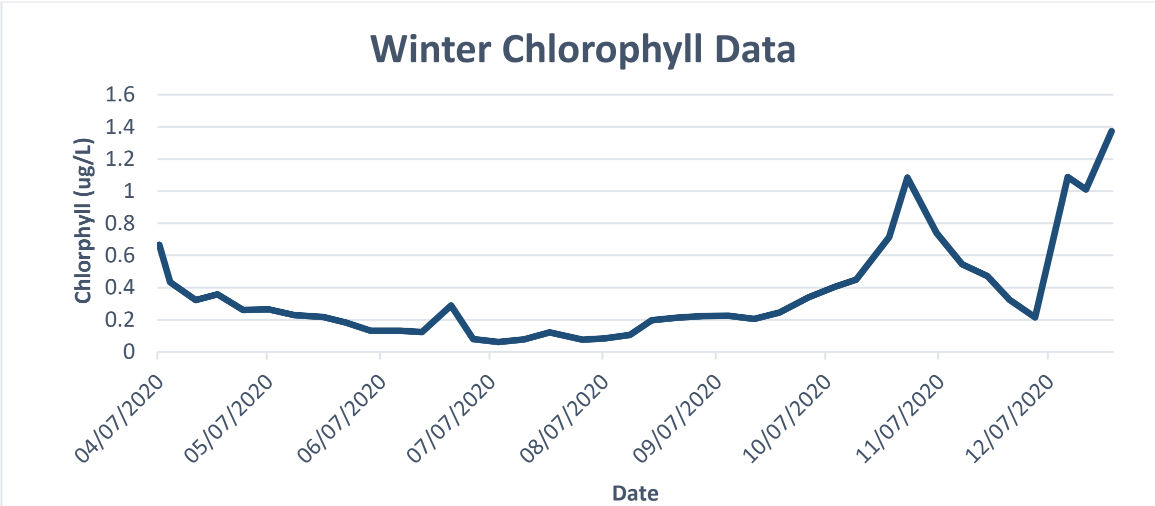


Fig. 3 – Winter chlorophyll (µg L^{-1}) samples collected from the pumphouse on station once per week.

In addition to LTER sampling, the Schofield lab collaborates with the C-045-P, C-020-P, C-013-P, and C-024-P groups conducting collaborative acoustic surveys, net tows, and predator observation surveys. Biophysical parameters and krill abundance are measured with five CTD deployments and an EK80 acoustic sensor along fixed transect lines in Palmer Canyon and near Biscoe Point (Fig. 4). To ground truth the EK80 and investigate a keystone species, net tows are conducted along the transect lines once per month to analyze krill and other zooplankton for biomass and abundance. To help reveal the interactions of the food web, observations of whales, penguins, sea-birds, seals, and other predators are recorded in relation to the acoustic surveys.

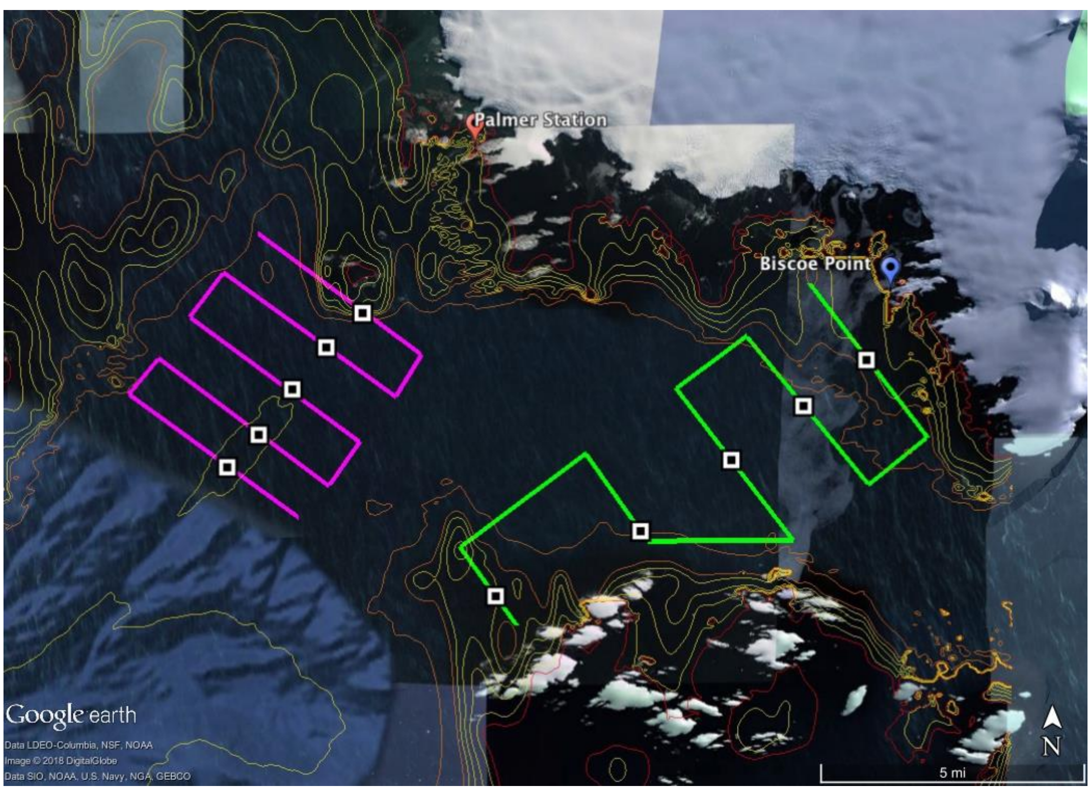


Fig. 4 – The Adélie Transect (pink line) in Palmer Canyon and the Gentoo Transect (green line) near Biscoe Point with five CTD stations each (square icons). Transect lines are based on penguin foraging patterns documented through penguin-tagging.

Working with the C-045-P group, 24-hour incubation experiments are planned twice per month. On 24-25 December, the first incubation was performed with pumphouse water sampling every four hours. The second incubation was performed on 30-31 December with water collected from Station E sampling every six hours (Fig. 5). The objective is to examine how different light levels affect the chemistry and community compositions of phytoplankton on a short time scale.

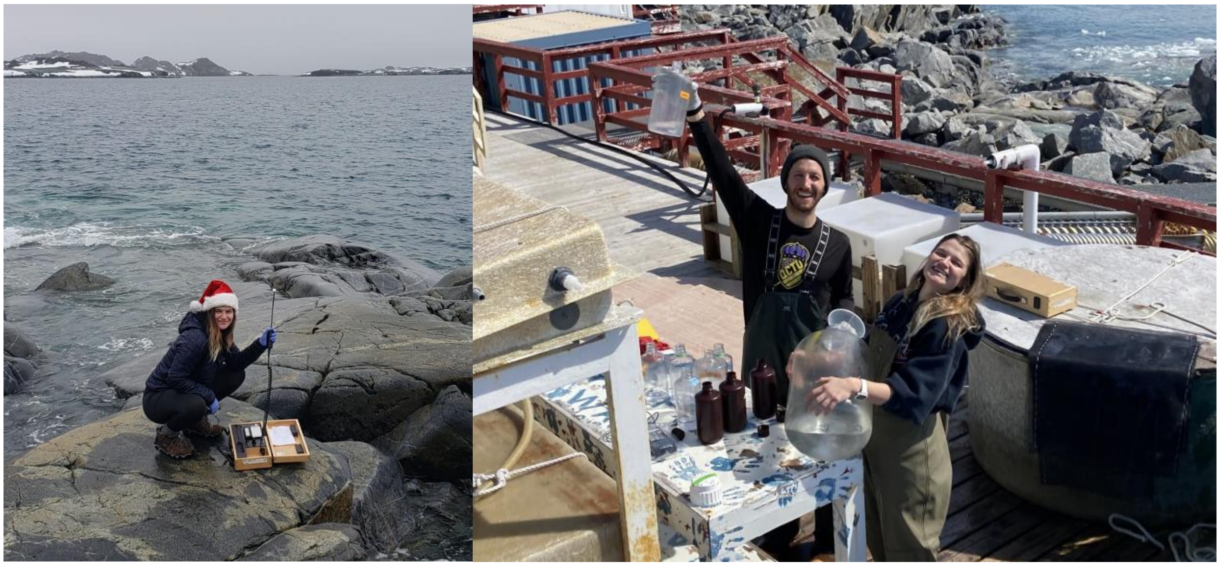


Fig. 5 – Rachael Young (left panel) using an irradiance meter to measure light levels, and Dan Lowenstein and Rachael Young (right panel) collecting water from a carboy.

The Scofield lab is extremely excited to be back at Palmer and looks forward to a productive and collaborative season. We appreciate all of the support staff and other science groups for their ongoing efforts!

C-045-P: PALMER, ANTARCTICA LONG TERM ECOLOGICAL RESEARCH (LTER): LAND-SHELF-OCEAN CONNECTIVITY, ECOSYSTEM RESILIENCE, AND TRANSFORMATION IN A SEA-ICE INFLUENCED PELAGIC ECOSYSTEM – MICROBIAL, BIOGEOCHEMICAL COMPONENT

Personnel on station: Daniel Lowenstein

The Van Mooy Lab is excited to begin our first year at Palmer Station as part of the Long Term Ecological Research (LTER) Project, despite challenges presented by the pandemic. Our primary goal remains very similar to that of our predecessor, Dr. Hugh Ducklow: to investigate seasonal microbial ecology and biogeochemistry along the western Antarctic Peninsula as the ecosystem changes. We also are eager to begin annual lipidomic and carbohydrate analyses to study how the microbial community approaches carbon and chemical energy storage throughout the summer – energy which will propagate through the food web and impact every aspect of the ecosystem.

Since our arrival with the summer turnover crew, we have set up the lab, calibrated our instruments, and begun sampling with a RHIB-deployed CTD cast on 19 December. We have since deployed the CTD once more, though we are currently troubleshooting software quirks.

We are intrigued by preliminary chlorophyll and cell count results, which suggest this year's minimal ice conditions (Fig. 6) led to greater mixing in the early spring than in previous years, preventing the typical, shallow phytoplankton bloom and resulting in a deeper, more gradual chlorophyll maximum (Fig. 7).

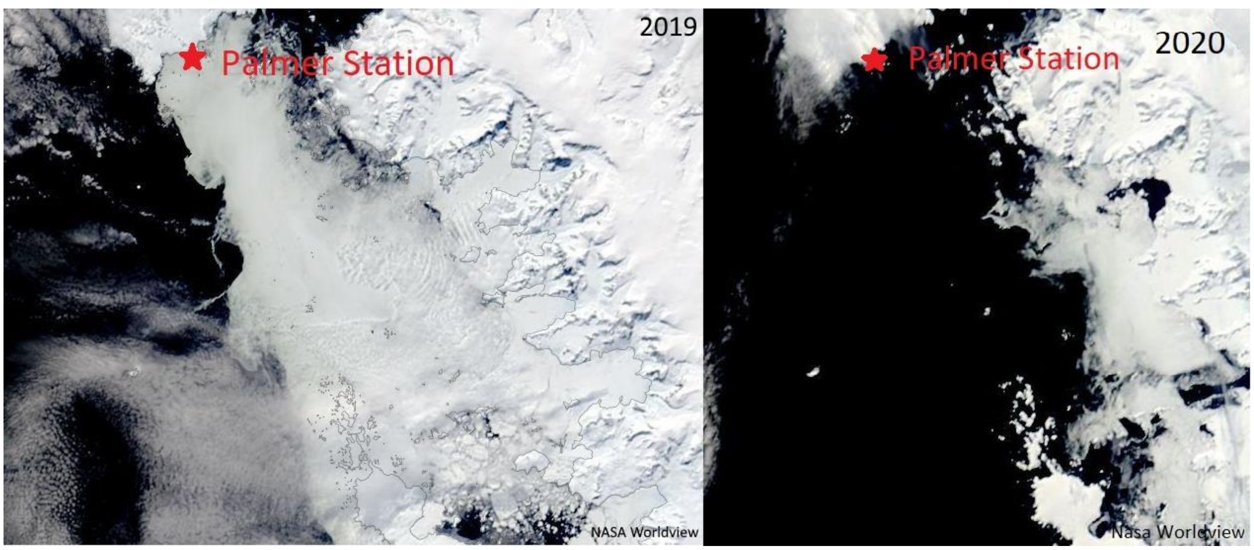


Fig. 6 – Pack ice along the western Antarctic Peninsula during the first week of December in 2019 (left panel) and 2020 (right panel).

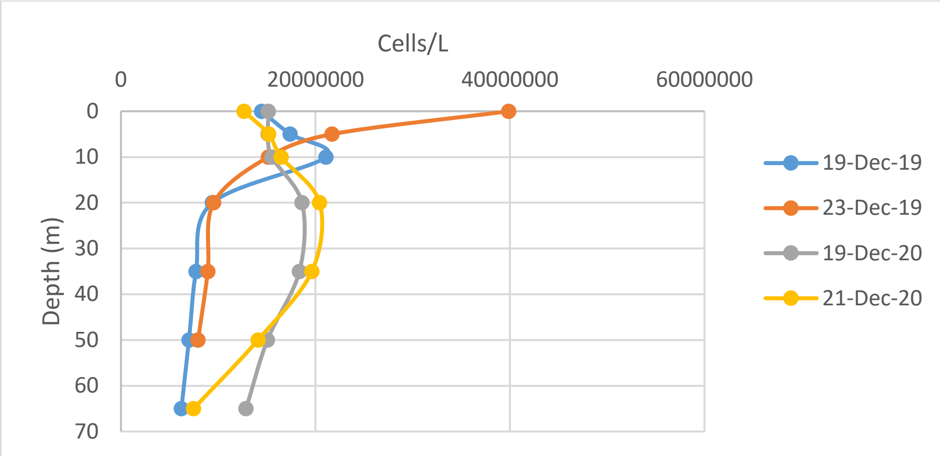


Fig. 7 – Autofluorescent phytoplankton cell counts from four CTD casts in December 2019 (blue and orange lines) and 2020 (gray and yellow lines), showing a shallow, concentrated phytoplankton bloom in 2019 and deeper, more diffuse maximum in 2020. (See also, chlorophyll fluorescence measurements in Figure 2, C-019-P report).

Working with Rachael Young from C-019-P, we took advantage of a foul weather day two weeks ago (40 knot winds) to run a 24-hour observational time series at Palmer's seawater intake pump, which pulls water from near the seabed, ~20 meters offshore in Arthur Harbor. Triplicate samples were collected at four-hour increments, from solar noon on 24 December to solar noon on 25 December (Fig. 8). C-045-P sampled for bulk particulate organic carbon (POC), lipids, carbohydrates, macronutrients, and cell counts of various microbial classes while Rachael Young sampled for chlorophyll fluorescence, photosynthetic efficiency, and species identification. We also measured light levels at sea level. Our goal is to elucidate how microbes allocate chemical energy storage throughout the day.

Fig. 8 – C-045-P lab member, Dan Lowenstein, preparing samples for flow cytometry analyses, with carbohydrate and lipid filtration samples on right. Christmas morning, 2020.

Our time-series flow cytometry results indicate roughly consistent levels of photosynthetic plankton (indicated by "total autofluorescence" cell counts, Fig. 9), but decreasing bacterial abundance (Fig. 10), likely reflecting a changing community structure as new water masses flow past Palmer's seawater intake. Once we have processed our lipidomic and carbohydrate samples in our lab in Woods Hole, lipid biomarkers will enable us to separate their chemical signatures and evaluate the bulk pools of energy storage.

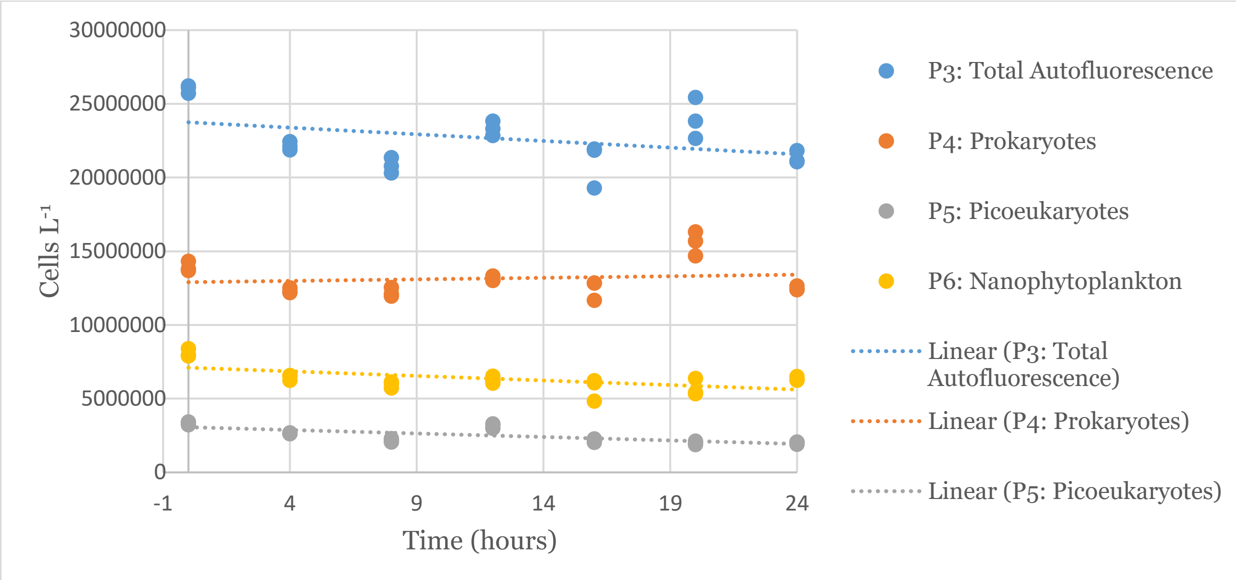


Fig. 9 – Autofluorescent phytoplankton cell counts from 24-25 December 24-hour time series experiment.

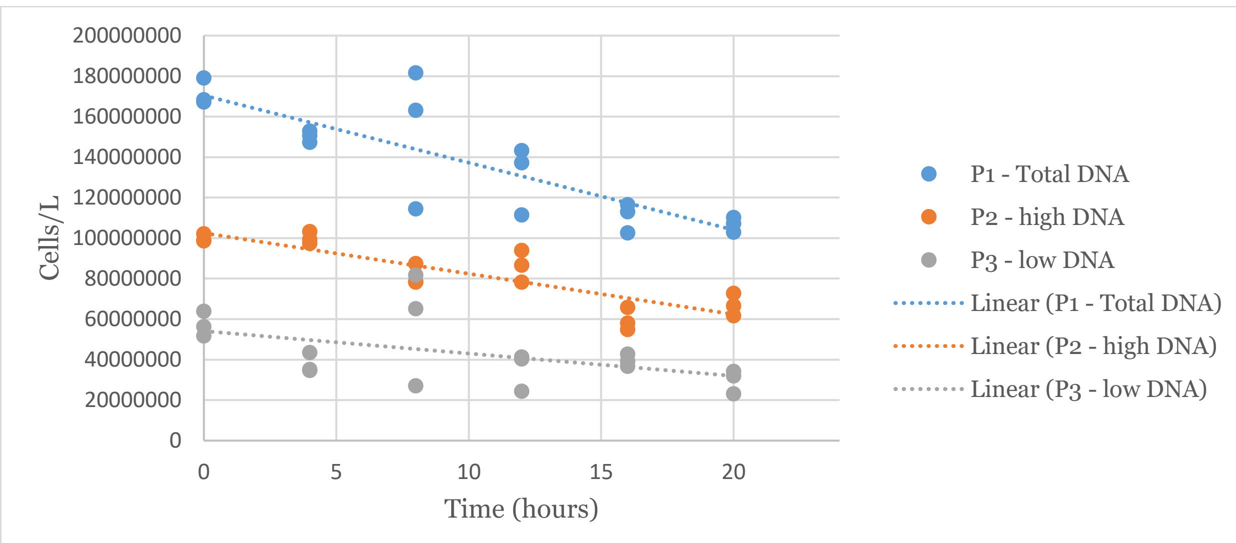


Fig. 10 – DNA-stained heterotrophic cell counts from 24-25 December 24-hour time series experiment. Insufficient DNA stain at final (24h) timepoint led to inadequate data measurement.

The MTs are still troubleshooting the RHIBs as they mobilize for the season, so we took the opportunity to run our planned collaborative 24-hour time series incubation experiments with C-019-P from 30-31 December. We collected surface water from LTER Station E, then setup the incubations in three flow-through tanks at various controlled light levels. We sampled for lipids, carbohydrates, and cell counts. On behalf of C-019-P, Rachael Young again sampled for chlorophyll fluorescence, photosynthetic efficiency, and species identification. These data will enable us to investigate diel energy cycling in the presence and absence of light signals, which will help elucidate microbial activity and carbon export throughout the water column.

We are also eager, when the opportunity presents, to sample directly from apparent blooms of the biogeochemically-significant colonial haptophyte alga, *Phaeocystis antarctica*, to investigate how environmental samples compare with recent *P. antarctica* culture analyses performed in our lab.

PALMER STATION RESEARCH ASSOCIATE MONTHLY REPORT
December 2020
Marissa Goerke

A-111-P: THE NEXT GENERATION OF GEOSPACE RESEARCH FACILITIES AT PALMER STATION: ELF/VLF RADIO WAVE OBSERVATIONS

Dr. Andrew Gerrard, Principal Investigator, New Jersey Institute of Technology

Extremely Low Frequency/Very Low Frequency (ELF/VLF) radio wave observations at Palmer Station (Fig. 11) 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.

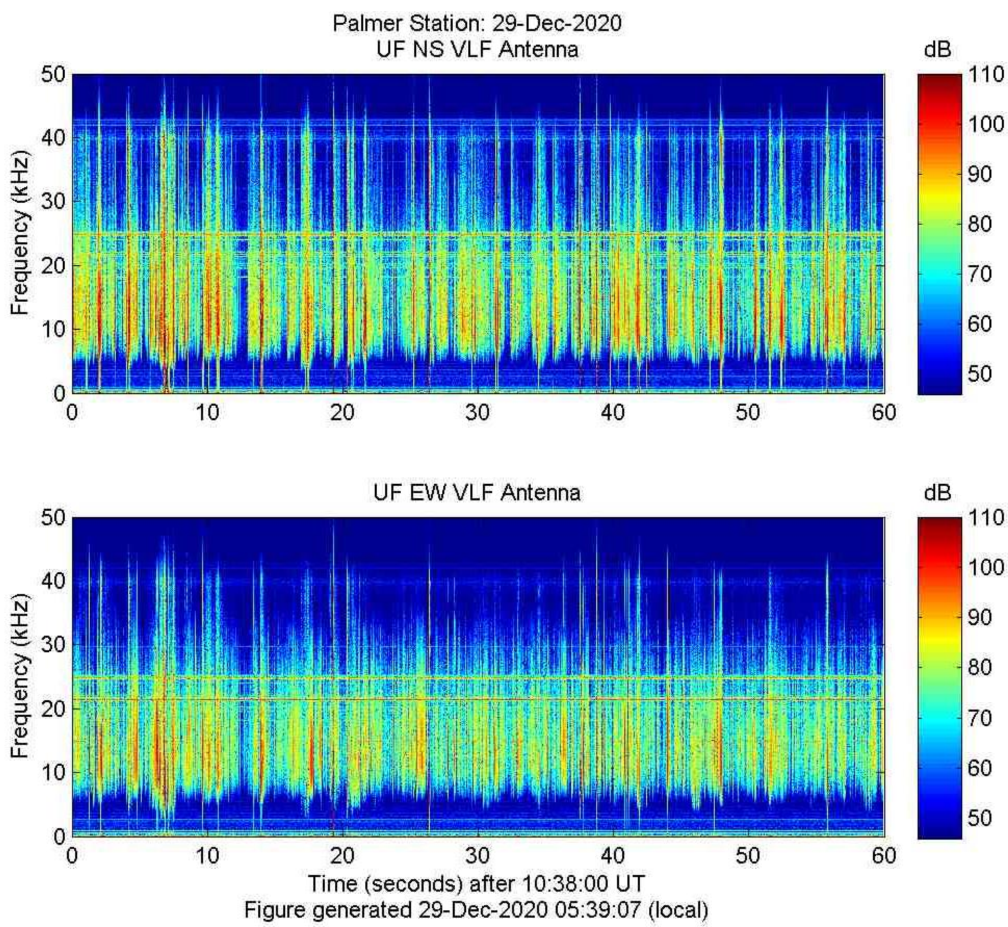


Fig. 11 – Real-time broadband ELF/VLF spectrogram from 29 December 2020. *Image Credit: University of Florida*

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: THE NEXT GENERATION OF GEOSPACE RESEARCH FACILITIES AT PALMER STATION: SAMBA MAGNETOMETER
Dr. 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 27 February 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 considered 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 30 September at 0745 local (UTC−03:00), the magnetometer was removed from 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)
Dr. Josh Kohut, Principal Investigator, Rutgers University, Institute for Marine and Coastal Sciences; Dr. William R. Fraser, Co-PI, Polar Oceans Research Group; Dr. Kim Bernard, Co-PI, Oregon State University; Dr. Harper Simmons, Co-PI, University of Alaska, Fairbanks; Dr. Matthew Oliver, Co-PI, University of Delaware; Dr. John Klinck, Co-PI, Old Dominion University

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 Joubin and the Wauwermans 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 operational this month and last month. The computers at the Wauwermans and Joubin sites are not sending data. Site visits have been requested by the Principal Investigator to trouble shoot possible problems. The visits have been delayed until there is favorable weather and vessel bandwidth to visit the islands. Data will be available in the future at: https://marine.rutgers.edu/~codaradm/.

G-090-P: GLOBAL SEISMOGRAPH NETWORK (GSN) SITE AT PALMER STATION
Mr. 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 CTBTO/IMS installation; CTBTO-specific protocols for the seismic system are covered in the CTBTO (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.

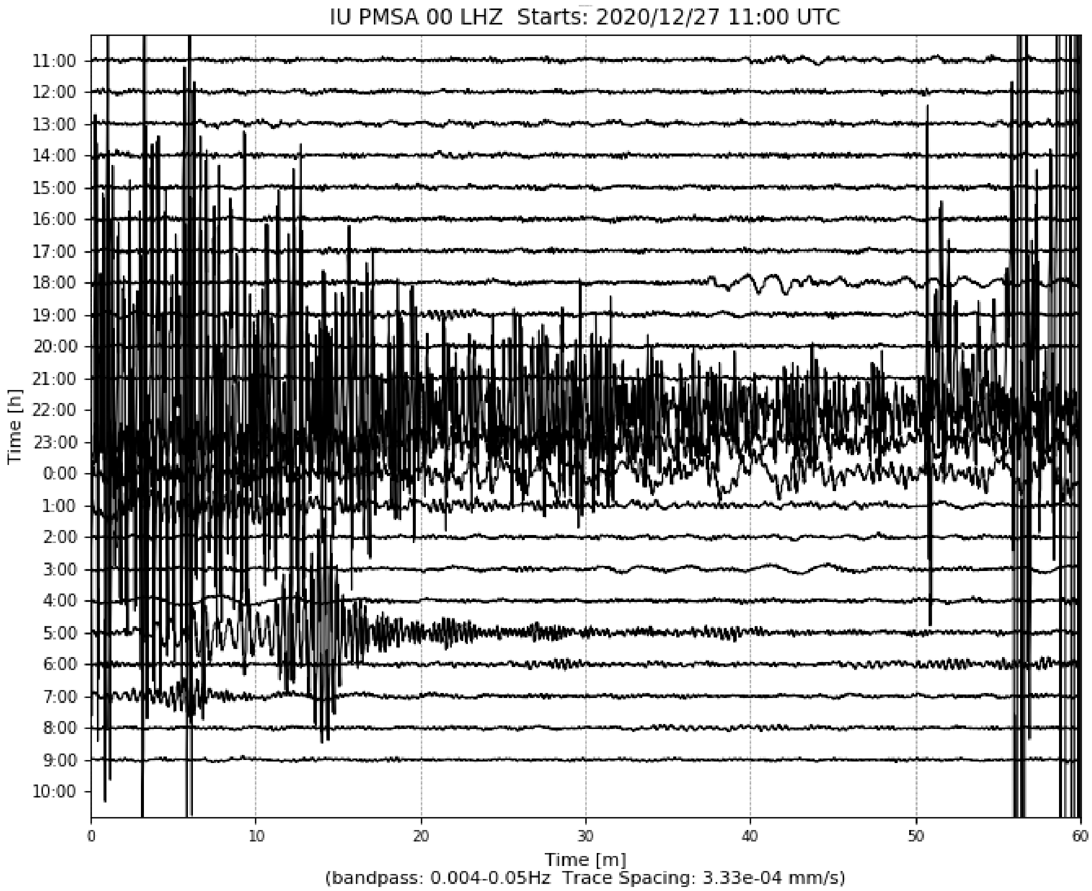


Fig. 12 – A 6.8 magnitude earthquake off the coast of Los Lagos, Chile 27 December 2020. *Image Credit: NASA Earthquake Hazards Program*

The system operated consistently throughout the month. The time stamp and seismic activity found on the heliplot was checked daily; see example in Figure 12. 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

Dr. 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 (Fig. 13).

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 low flask inventory, the RA has been instructed by the Principal Investigator to only sample once a month starting this month.

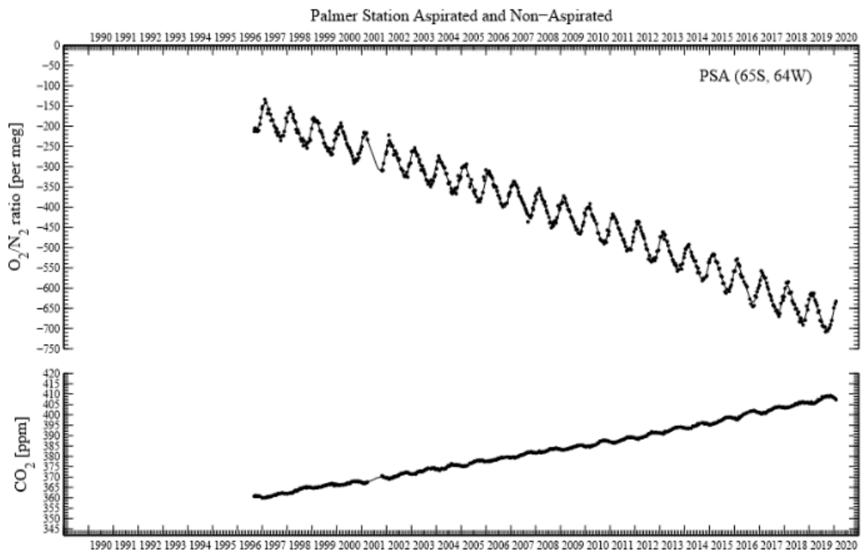


Fig. 13 – Historical plot of O_2/N_2 ratio per meg and CO_2 ppm updated on 29 July 2020. *Image Credit: UCSD Scripp's O_2 Program*

Air samples were collected on 17 December at 1620 local (UTC−03:00). 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. Due to a low flask inventory, the grantee has asked for a single sample on or near the 15th of each month, beginning this month and continuing until cargo can be shipped more often than twice a year. 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.

This data was shared with the onsite LTER grantees because it has interesting collaboration potential.

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

Dr. James Butler, Principal Investigator, National Oceanic and Atmospheric Administration / Global Monitoring Division

Mr. Don Neff, and Dr. Steve Montzka, National Oceanic and Atmospheric Administration / Global Monitoring Division

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 (Figs. 14 and 15). 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 4 December 4 at 1326 local, 12 December at 1007 local, 25 December at 0915 local, 19 December at 1010 local (all UTC−03:00) during favorable wind conditions. This data was shared with the onsite LTER grantees because it has interesting collaboration potential. More information and data for the Carbon Cycle group can be found at: https://www.esrl.noaa.gov/gmd/ccgg/trends/.

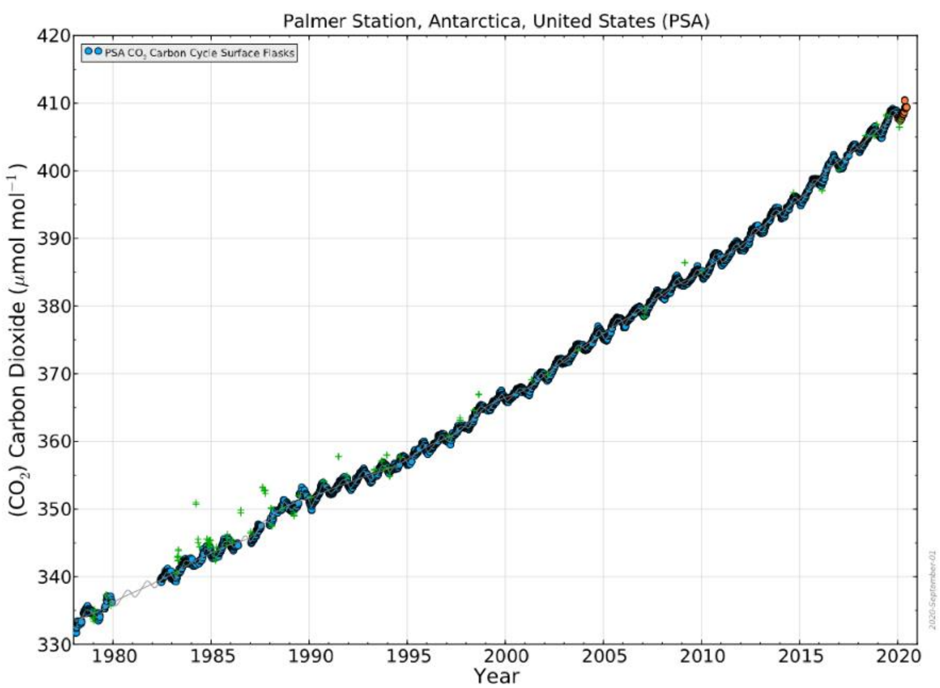


Fig. 14 – Historical CO_2 Levels at Palmer Station dating back to 1978. Orange dots are preliminary data. *Image Credit: NOAA Global Monitoring Laboratory*

The Halocarbons and other Atmospheric Trace Species (HATS) samples were collected on 8 December at 1312 local and 23 December at 1328 local (all UTC−03:00) during favorable wind conditions. More information about the Halocarbons and other Atmospheric Trace Species group available at: https://www.esrl.noaa.gov/gmd/hats/.

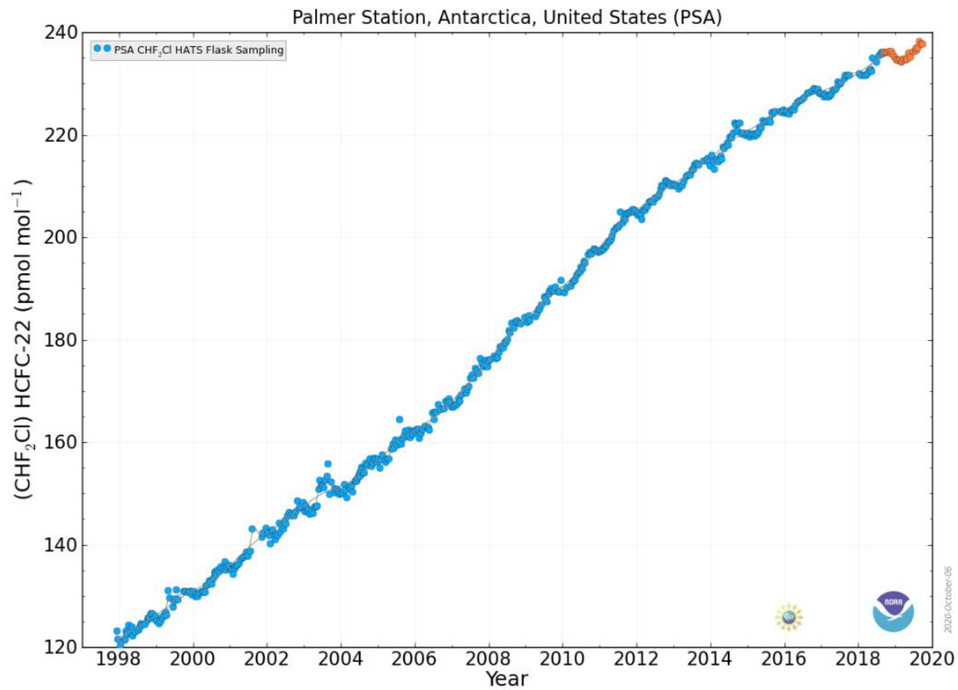


Fig. 15 – Historical measurements of HCFC-22, one of the halocarbon and trace gases measured at Palmer Station. Orange dots are preliminary data. *Image Credit: NOAA Global Monitoring Laboratory*

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

Dr. James Butler, Principal Investigator, National Oceanic and Atmospheric Administration / Global Monitoring Division
Mr. Scott Stierle, National Oceanic and Atmospheric Administration / Global Monitoring Division

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 (Fig. 16).

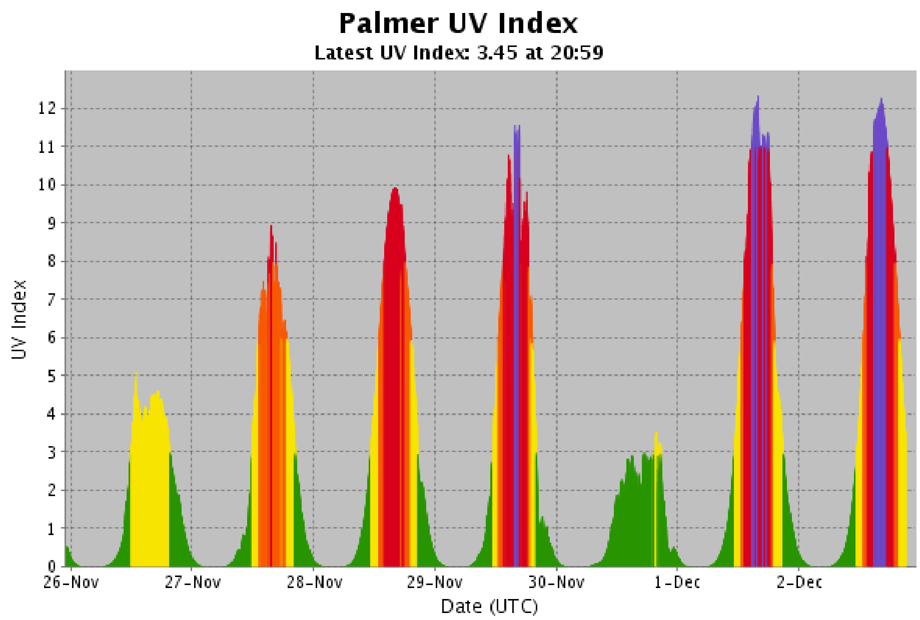


Fig. 16 – UV index generated from the GUV-511 radiometer in real time between 26 November and 3 December. *Image Credit: NOAA Earth Systems Research Laboratory*

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 APC Power Strip, but issues continue with the bridge rectifier on the Spectralink power supply circuit board. The faulty power supply was pulled and replaced this month to correct the reoccurring power issue. The log was completed and collectors were cleaned on a daily basis. Weekly instrument 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 3 December and 31 December as scheduled without issues. The quarterly SUV-100 UV triple absolute scan was performed on 17 December as scheduled without issues. Sheathbill guano on the roof has been notable problem this month.

Figure 17 shows the progress of the ozone hole during 2020. The gray shading indicates the highest and lowest values measured since 1979. The red numbers are the maximum or minimum values. The temperature of the stratosphere and the amount of sunlight reaching the south polar region control the depth and size of the Antarctic ozone hole. The southern stratosphere has maintained a steady polar vortex this year much later than in past years. This season saw an exceptionally large ozone hole that remained open longer into the summer than average (Fig. 18).

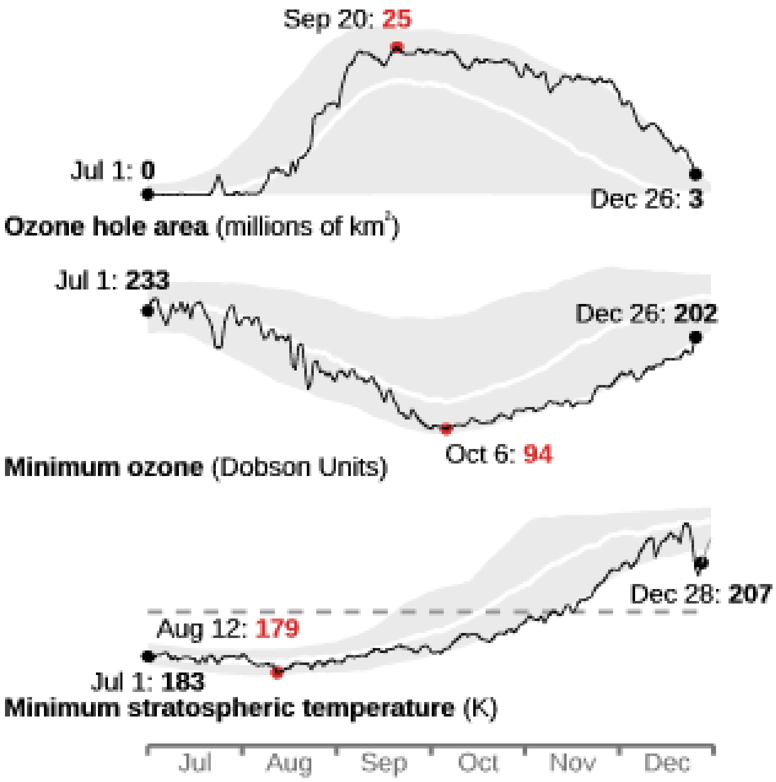


Fig. 17 – Ozone hole area (millions of km^2), minimum ozone concentration (Dobson units), and minimum stratospheric temperature (Kelvin) for the 2020 Ozone Hole Season. Gray shading indicates the highest and lowest values measured since 1979. Red numbers are the maximum or minimum values. *Image Credit: NASA Ozone Watch*

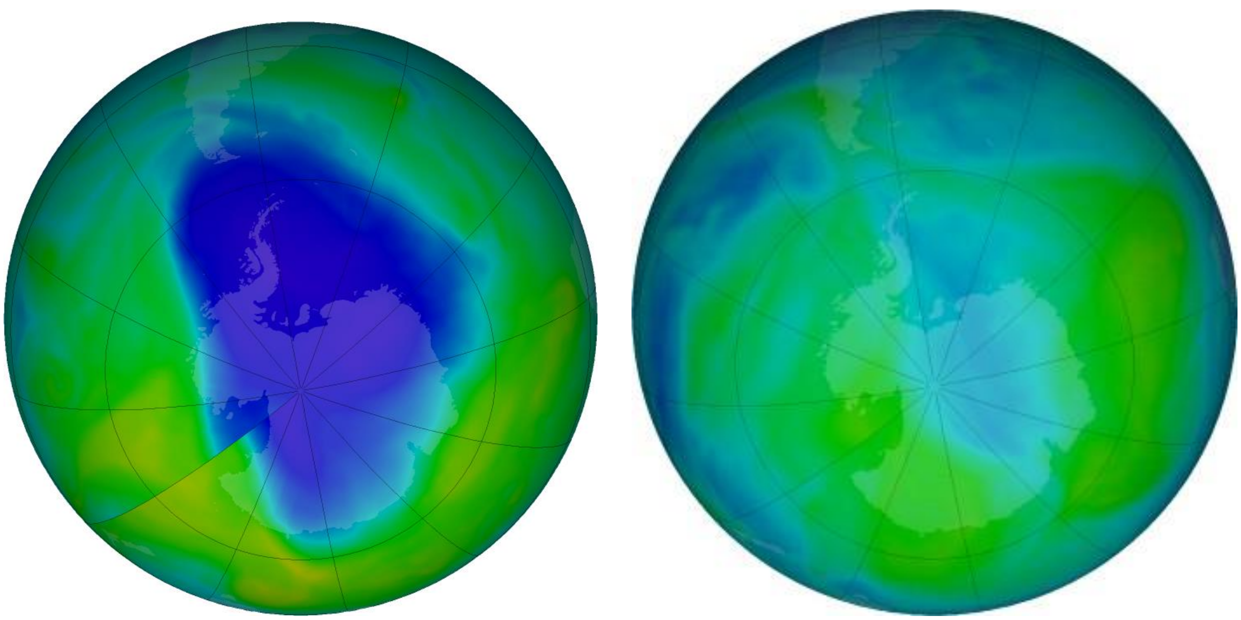


Fig. 18 – NASA false color view of the ozone hole (blue/indigo colors are low ozone concentrations, and yellow/green colors are high ozone concentrations) showing the breaking up of the ozone hole between 1 December (left panel) and 29 December (right panel). *Image Credit: NASA Ozone Watch*

For more information visit: https://esrl.noaa.gov/gmd/grad/antuv/.

R-938-P: TERASCAN SATELLITE IMAGING SYSTEM
Mr. Kevin Bliss and Mr. Justin Maughmer, Principal Investigators, System Administrators, 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 (Fig. 19).

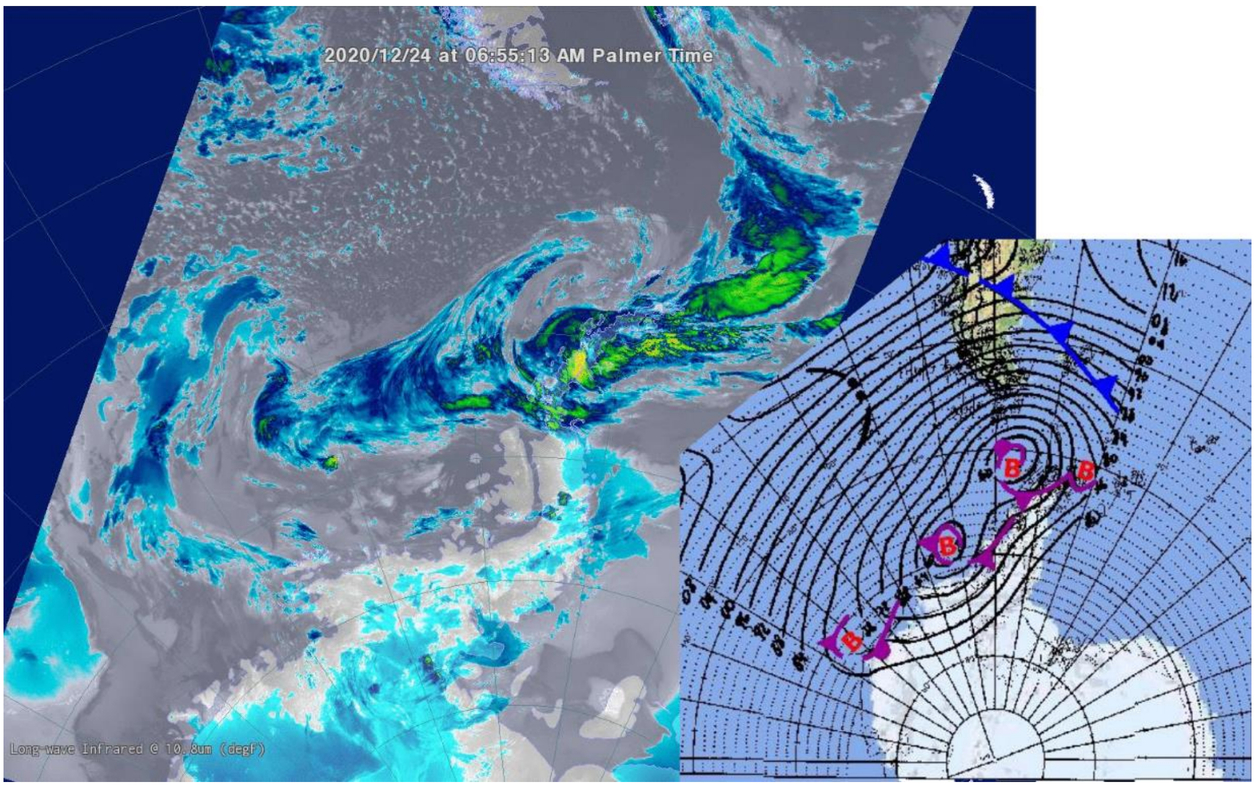


Fig. 19 – NOAA-18 satellite pass from 24 December (main panel) compared with an occluded front passing over Palmer Station (right overlay panel).

The imagery was checked daily. Data from the NOAA satellites appears 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.
Mr. Joe Pettit, Principal Investigator, UNAVCO

The National Science Foundation (NSF) tasked and funded the USGS Antarctic Program to establish a Global Positioning System (GPS) 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.

The NASA Jet Propulsion Laboratory (JPL/NASA) is contracted to maintain the system, and sub-contracts 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 their discretion.

The system operated consistently throughout the month. The lights on the Trimble, Javad, and Ashtech Receivers were all illuminated in the correct pattern and showed no signs of interruption. Data flow was monitored and was normal throughout the month. 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 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 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 in real-time via a virtual private network (VPN) 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.

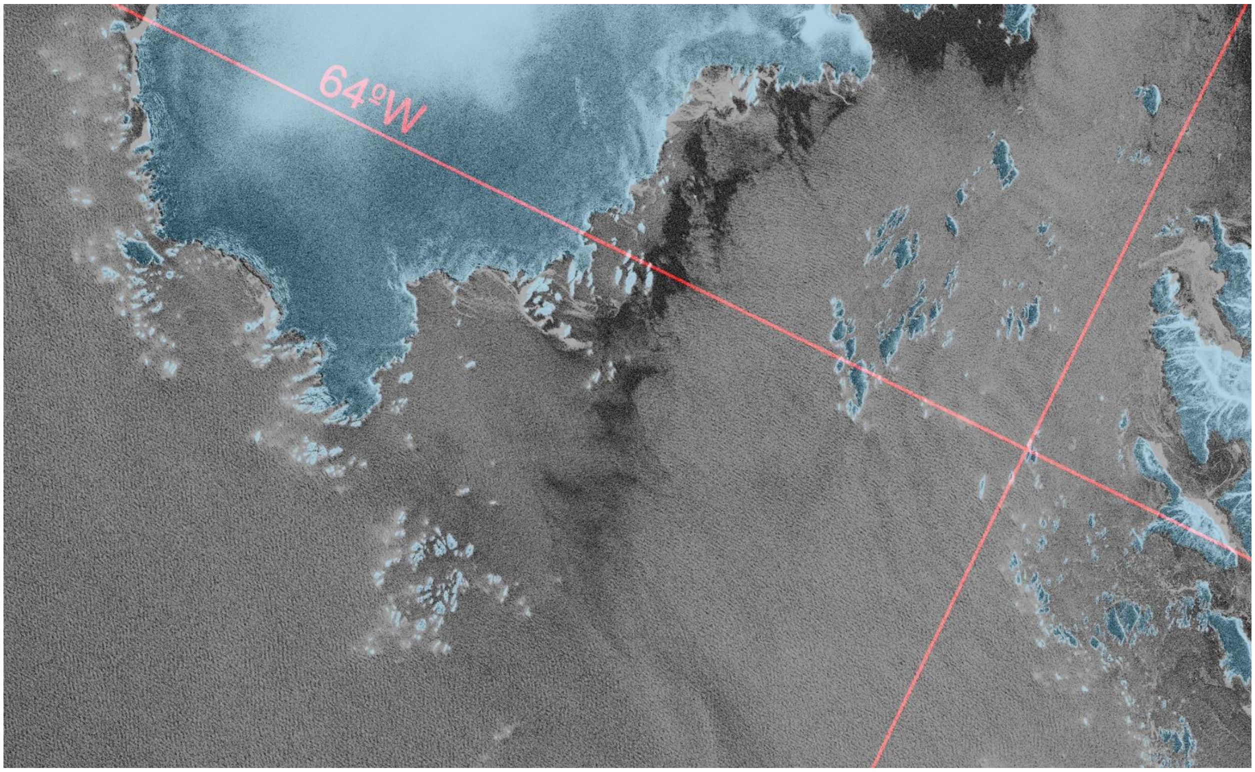
The system operated consistently this month. The RASA GUI was checked daily. The amount of filter material was checked as needed and no anomalies were heard coming from the blower. Daily filters were processed and the monthly log was sent as needed. A planned power outage on 11 December shut down the blower for two <10 minute intervals. Additional details about the treaty and monitoring stations can be found on the CTBTO web site, https://www.ctbto.org/.

PHYSICAL OCEANOGRAPHY

Palmer Station has a tide and conductivity gauge located on the pier at 64.774563°S 064.054837°W at a height of (base datum) 12.13 meters. 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 to the R/V *Nathaniel B. Palmer* when imagery was available. 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 26 December 2020. *Image Credit: EC Copernicus data/ESA/CMEMS/Polar View*

METEOROLOGY

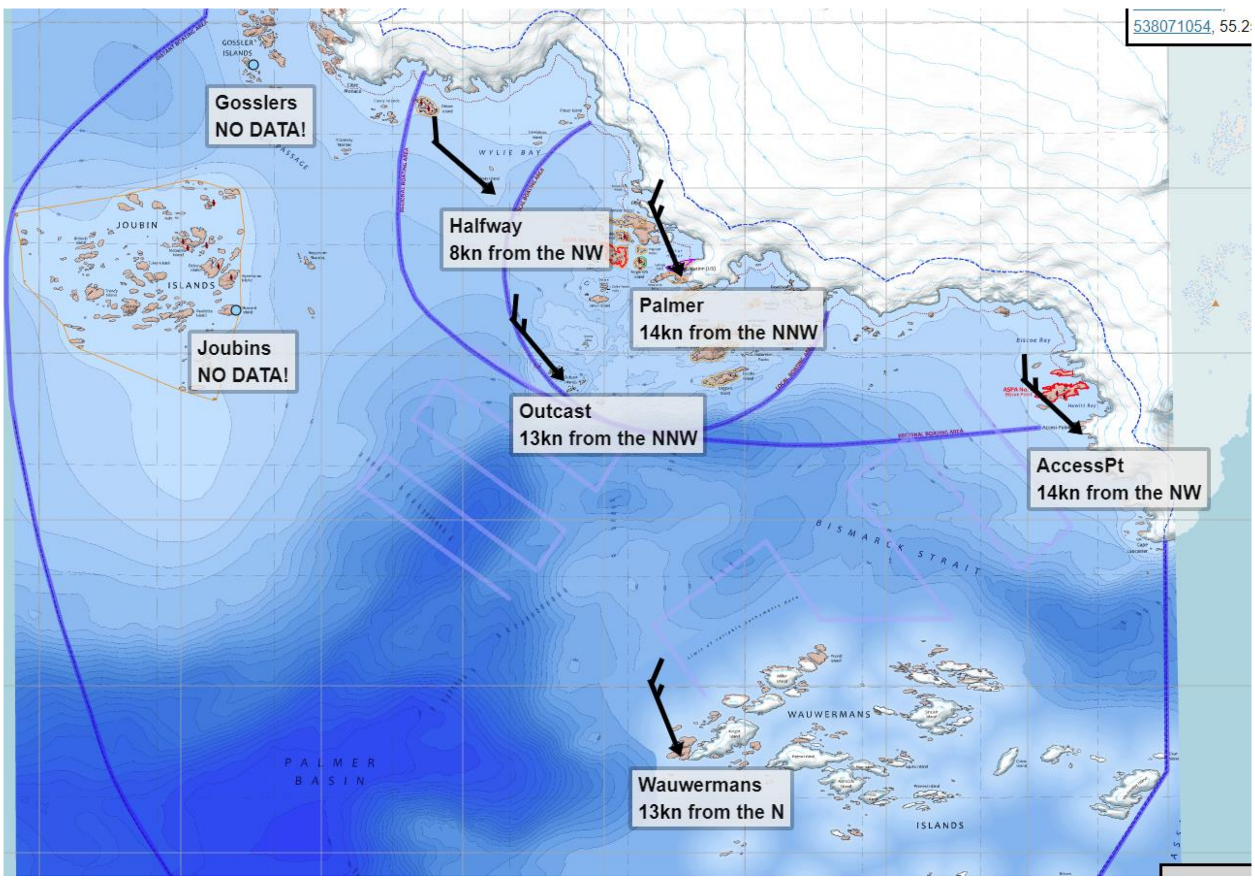
Mike Carmody, Principal Investigator, United States Antarctic Program

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 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°S 064.047440°W 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 accumulations are 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 Gossler Islands that will need to be addressed during a site visit. AWS1 has been having an issue with its temperature sensor. AWS2 at the Joubin Islands site went down, most likely due to a battery charger fault which will 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 29 December 2020. *Image Credit: IT&C and Research Associate*

Palmer Monthly Met summary for December, 2020

Temperature
Average: 0.6 °C / 33.2 °F
Maximum: 6.0 °C / 42.8 °F on 24 Dec 17:38
Minimum: -2.9 °C / 26.8 °F on 2 Dec 05:42
Air Pressure
Average: 978.3 mb
Maximum: 995.2 mb on 9 Dec 22:26
Minimum: 954.7 mb on 1 Dec 05:31
Wind
Average: 10.6 knots / 12.2 mph
Peak (5 Sec Gust): 52 knots / 60 mph on 10 Dec 12:49 from NNE (23 deg)
Prevailing Direction for Month: NNW
Surface
Total Rainfall: 71.4 mm / 2.81 in
Total Snowfall: 11 cm / 4.3 in
Greatest Depth at Snow Stake: 77.2 cm / 30.1 in
WMO Sea Ice Observation: 1-6 icebergs with growlers and bergy bits
Average Sea Surface Temperature: 0.09 °C / 32.2 °F