PALMER STATION MONTHLY SCIENCE REPORT

August 2022

Giant petrels nesting on Bonaparte Point, a sheathbill in flight, a leopard seal surfacing, and winter-overs enjoying a sunny hike (clockwise from top left image). *Image Credits: Shawn Wilson.*

NEWS FROM THE LAB
Angela Klemmedson, Winter Laboratory Supervisor

August was a joyful month at Palmer Station. We celebrated the first annual World Krill Day and the beginning stages of Antarctic springtime, which was discernable from the noticeably longer days and more frequent wildlife viewings.

The introduction to last month's Science Report focused on World Krill Day, as we prepared for the live event that was hosted by the National Science Foundation from Palmer Station. The event took place on August 11th and was a huge success, thanks to Dr. Kim Bernard and her wonderful wintering team of Julia Fontana and Giulia Wood. Over 200 viewers from all around the world tuned in to the event, and since then, over 1,300 people have watched the recording on YouTube.

During the event, Kim talked about the importance of Antarctic krill to the Southern Ocean food web and to the global carbon cycle. Kim also shared what life at Palmer Station is like – especially during the wintertime – through some videos she prepared as part of the outreach portion of her research project. We learned about the reasoning behind her research questions and got an overview of the krill experiments taking place this winter.

Station personnel have been enjoying the beginning of springtime and the longer days that come with that. It is now light for the majority of the workday, and even into dinnertime. As for returning wildlife, we have been seeing many curious sheathbills poking around station, crabeater and Weddell seals lounging on the sea ice within Hero Inlet, a leopard seal was sighted last week near the pier, and many giant petrels are making nests on Bonaparte Point and the nearby islands. Throughout the month, we have been seeing a group of about ten gentoo penguins gathering at Point 8 in the mornings and evenings, and last week we even saw a pair of Adélie penguins in Hero Inlet from the windows in the galley!

In terms of weather, August was a warm and stormy month. Both the average and minimum temperatures for August were warmer than for any other August on record. See the Monthly Weather Synopsis section of this report for details. Besides a small amount in Hero Inlet, there was still no sea ice around station, which is unusual for this time of year. Interestingly, August 2022 snowfall tied with August 2003 for a record high snowfall of 73 cm. However, this record snowfall was not readily apparent because the snow accumulation was very low – the snow melted or blew away before too much accumulated.

During August, Palmer Station also celebrated receiving an award for the short film we submitted to the Winter International Film Festival of Antarctica (WIFFA). Our film was a fictional portrayal of a krill experiment gone terribly wrong, titled "It's Hungry", and it won for Best Cinematography.

B-459-P: CAREER: "THE OMNIVORE'S DILEMMA": THE EFFECT OF AUTUMN DIET ON WINTER PHYSIOLOGY AND CONDITION OF JUVENILE ANTARCTIC KRILL

Dr. Kim Bernard, Principal Investigator, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University

Personnel on Station: Kim Bernard, Julia Fontana, and Giulia Wood

Long-Term Feeding Experiment: This month, we conducted the third of our experimental time points (August 15-22). As for the previous time points, we ran one growth and three respiration experiments, and collected 120 krill to measure lipid, protein and CHN contents. Daily growth rates (DGR) have been significantly higher in the MIX tank (krill supplemented with a mixed diet of both diatoms and copepods) and the DIA tank (krill supplemented with a diatom diet) than those in the NAT tank (krill not supplemented with food) ($p < 0.05$; Figure 1.A). This is an exciting result that we look forward to exploring in further detail soon! DGR increased significantly from May to July and August ($p < 0.05$; Figure 1.B). Inter-molt period (IMP) was significantly higher in June (~90 days) than July (~23 days; $p = 0.026$) and August 3 (~33 days; $p = 0.054$), indicating that the krill are molting more frequently as the winter season progresses. There has been no significant difference in respiration rates between tanks (Figure 1.C). Respiration rates have varied significantly between months, though there is no linear trend in this variability. Respiration rates initially dropped from May to June, but then were observed to be elevated again in July, decreasing again in August ($p < 0.05$; Figure 1.D). In both respiration rates and DGR, there has been a high degree of variability between individual krill.

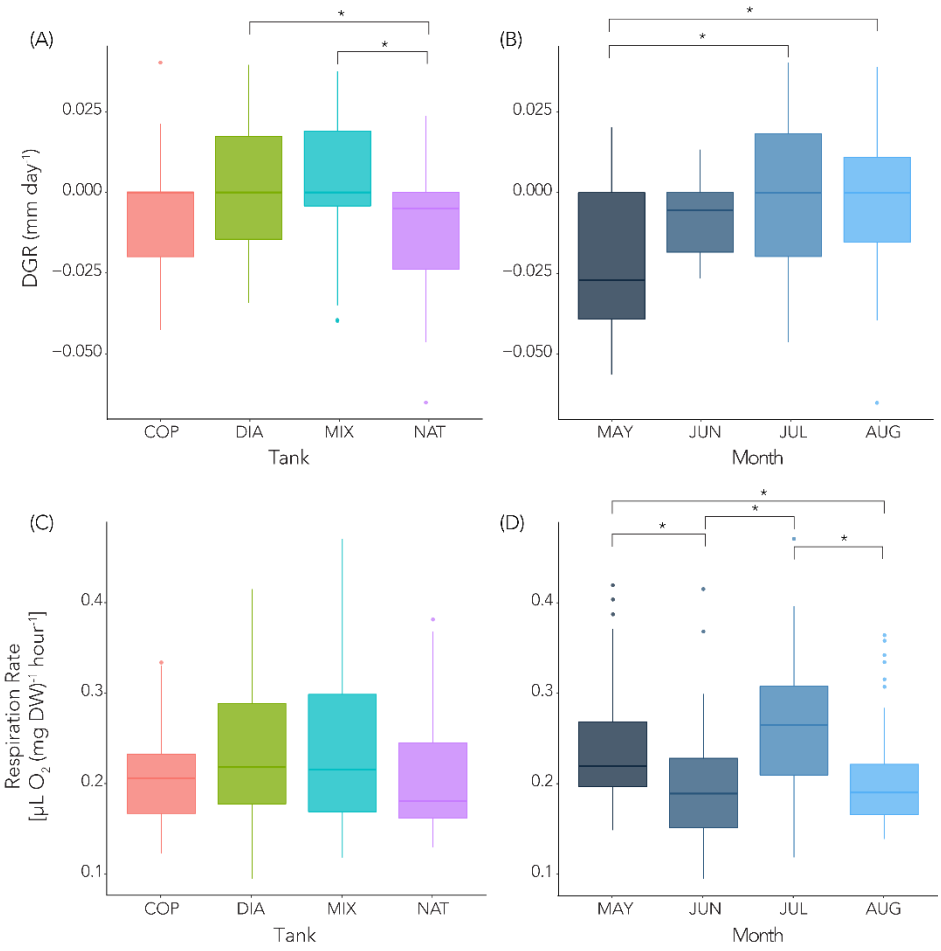

Figure 1. *Mean daily growth rates, DGR (mm day^{-1}) of krill (A) in each of the four tanks, and (B) by month. Mean respiration rates [µL O_2 (mg DW)$^{-1}$ hour^{-1}] of krill (C) in each of the four tanks, and (D) by month. Significant differences ($p < 0.05$) are shown with an asterisk (*). COP = supplemented with copepod diet; DIA = supplemented with diatom diet; MIX = supplemented with mixed diet of both copepods and diatoms; NAT = not supplemented with additional food.*

Outreach: As of 08/31/2022, the 20 short videos about our research and life in the field that are posted on Instagram and Twitter (both @psycho_kriller) received a total of 27,187 views. Our team was heavily involved in the inaugural World Krill Day (WKD, August 11th). Leading up to WKD, Pew Charitable Trusts published an interview with PI Bernard primarily about Antarctic krill but also about research and life in Antarctica. PI Bernard was invited to write a personal blog for Pew Charitable Trusts that was published on WKD. PI Bernard also contributed to Pew's online krill quiz by recording the video introduction. The entire team (Bernard, Fontana, and Wood) contributed to the creation of 19 tweets as part of an NSF Twitter Takeover held on WKD. In total, these tweets received 108,753 impressions, 25 comments, 190 shares, and 732 likes. The team also conducted a live webinar from the Palmer Station laboratories, hosted by the NSF. Over 200 people attended from 34 different states and 10 countries. The recorded webinar has been viewed 1,363 times on YouTube. We would like to give a special thank-you to our IT expert, Ryan Gasik, who ensured that it all ran smoothly and who helped us with a very professional set-up!

Team Krillers! Julia Fontana, Kim Bernard, Giulia Wood (left to right). *Image Credit: Julia Fontana.*

Looking Ahead: During our final month at Palmer Station, we will conduct TP4 and will wrap up our experiments. We will continue processing samples collected during TP3.

RESEARCH ASSOCIATE MONTHLY REPORT
August 2022
Ben Rosen-Filardo

Research Associate performs an SUV Absolute Calibration (O-264-P) on the Terra Lab roof.
Image credit: Angela Klemmedson.

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

Andrew Gerrard, Principal Investigator, New Jersey Institute of Technology

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

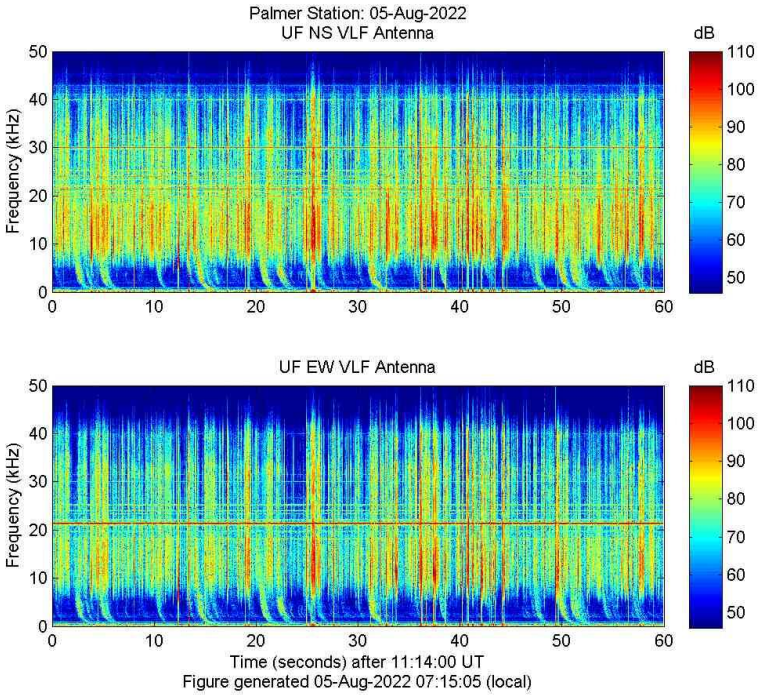

Figure 2. *Real-Time broadband VLF Spectrogram from Palmer Station, Antarctica.*

Both the Extremely Low Frequency and Very Low Frequency systems operated well this month. The spectrograms were reviewed daily and bi-weekly antenna inspections were done as weather allowed.

Current VLF/ELF data from Palmer Station can be observed at:
http://halo.ece.ufl.edu/realtime_palmer_bb.php.

A-111-P: SAMBA MAGNETOMETER

Andrew Gerrard, Principal Investigator, New Jersey Institute of Technology

The three-axis fluxgate magnetometer at Palmer is one in a chain of eleven longitudinal, ground-based magnetometers extending down 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 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 September 30th, 2020 at 7:45am local time, 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 when requested. 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.

Two of the three sites' transmitter and receivers were shipped north on LMG21-11. The system is still continuously collecting data from the remaining site. The PI has deemed the data useful information from the single site.

The 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.

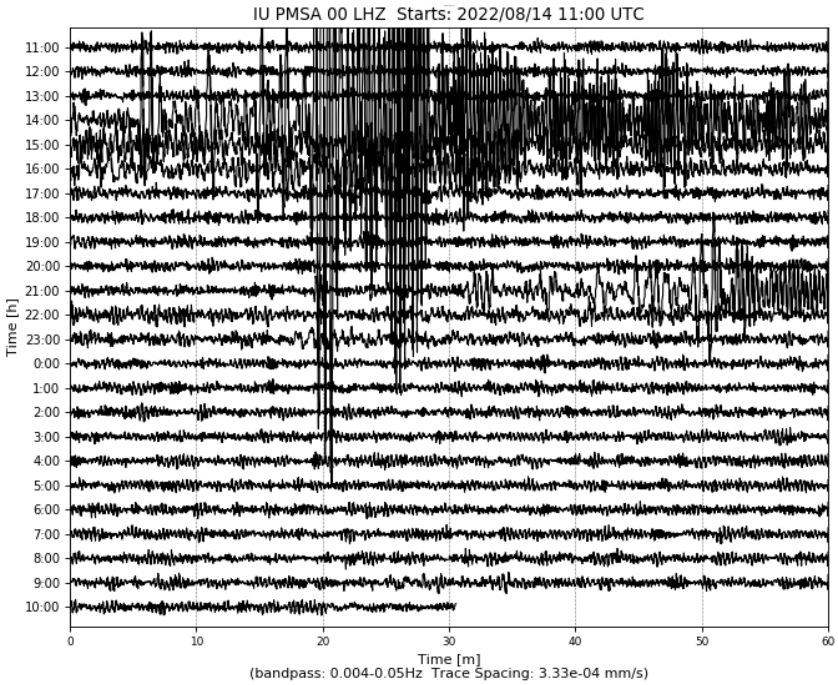

Figure 3. *Two earthquakes occurring on August 14, 2022 in the South Pacific Ocean.*

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 processes, which bring oxygen depleted waters from depth up to the surface. These exchanges lead to variations in the

oxygen content of the air above the water, and these changes are rapidly mixed around the latitude band by zonal winds. Measurements of the seasonal variations in oxygen content at Palmer and other sites may be valuable for documenting changes in the biological productivity of the southern oceans over time.

The percentage changes in oxygen are very small. Relative to the 20.95% background, the summer-winter differences are only about 0.01%. Some special precautions are necessary so that the O_2 content of the samples isn't perturbed at this low level. Among these precautions are maintaining a constant pressure and temperature in the flasks during sampling. This dictates the installation of the sampling station indoors and the use of a pump module with a bypass valve for avoiding pressure buildup. The Research Associate collects samples fortnightly from Terra Lab.

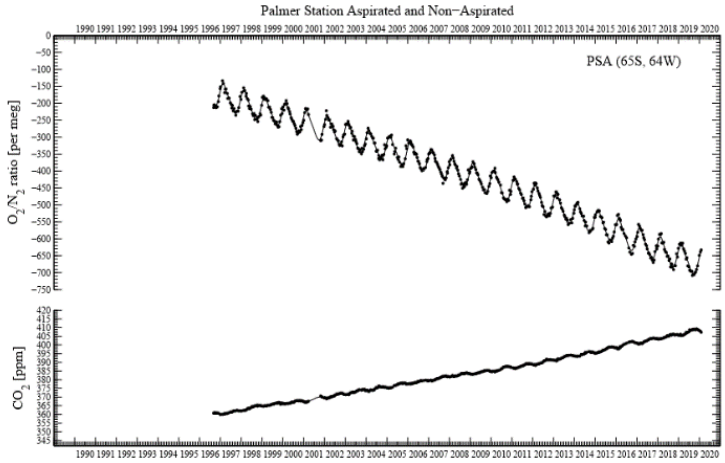

Figure 4. *Historical plot of* $\boldsymbol{O_2/N_2}$ *ratio per meg and* $\boldsymbol{CO_2}$ *ppm updated on July 29, 2020.*

Air samples were collected on August 1 and August 17. Wind conditions must equal or exceed 5 knots from a direction between 5° to 205° constantly for over an hour with no interference from human traffic on foot or in vessels. These air samples 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. 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 August 1, August 8, August 16, August 22, and August 29 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/.

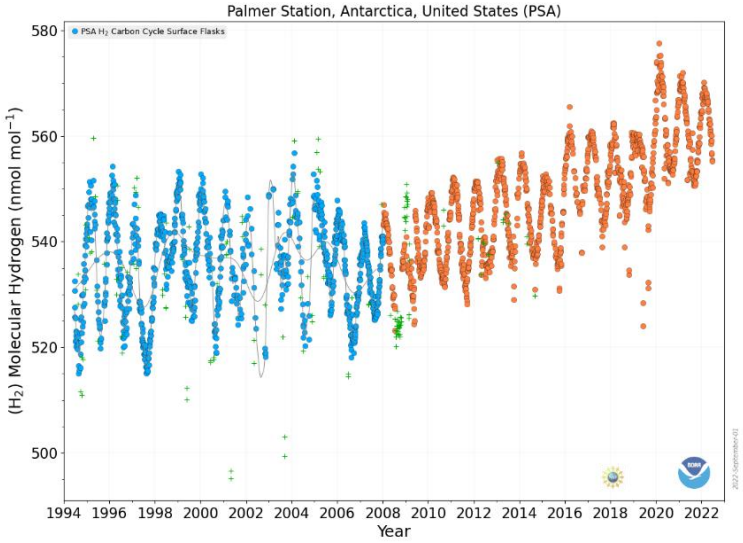

Figure 5. *Molecular Hydrogen (H2) levels at Palmer Station dating back to 1994. Orange dots are preliminary data.*

Halocarbons and other Atmospheric Trace Species (HATS) samples were collected on August 8 and August 24 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.

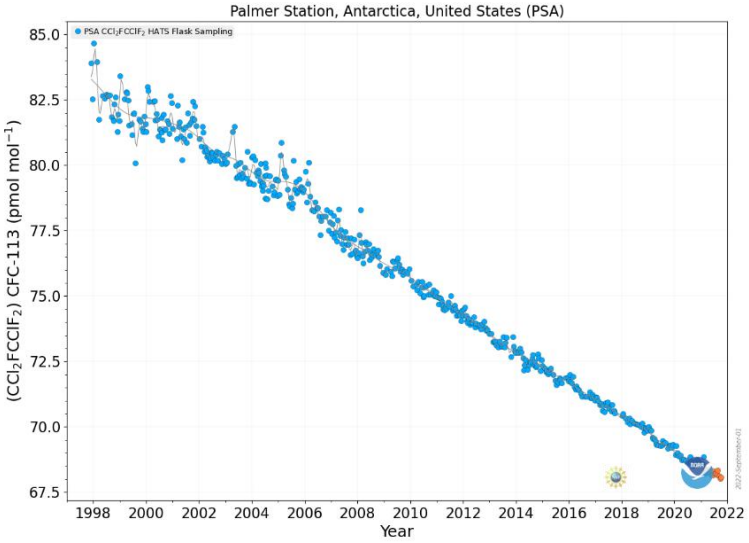

Figure 6. *CFC-113 (CCl_2FCClF_2) levels at Palmer Station dating back to 1998, one of the Halocarbon and Trace Gases measured at Palmer Station.*

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.

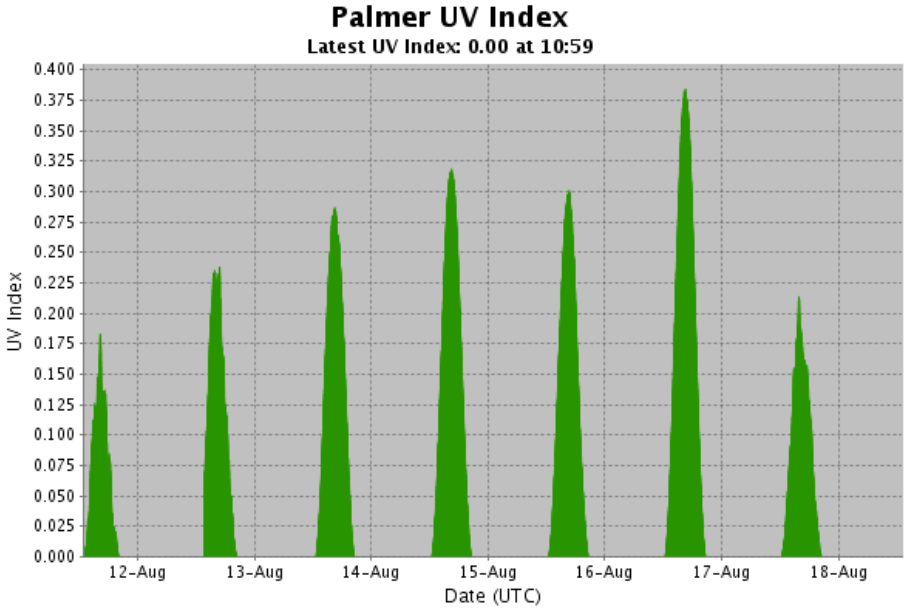

Figure 7. *UV index generated from the GUV-511 radiometer in real time.*

The log was filled out and collectors were cleaned on a daily basis. Once a week level checks were performed to confirm that the instrumentation was within +/- 0.2 degrees. The weekly log was sent out each Monday and bi-weekly SUV-100 UV Absolute Scans were performed on August 13 and August 27 without issues.

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

R-938-P: TERASCAN SATELLITE IMAGING SYSTEM
Justin Maughmer, Principal Investigator, System Administrator, United States Antarctic Program

TeraScan is an integrated system of hardware and software designed for automated reception of data from meteorological/environmental satellites and for processing the data into images and data overlays. The system collects, processes, and archives DMSP and NOAA satellite telemetry, capturing approximately 25-30 passes per day. The data files for these images and overlays are of a special format called TeraScan Data Format (TDF). The Research Associate operates and maintains on-site equipment for the project. The TeraScan weather and ice imagery is used for both research and station operations.

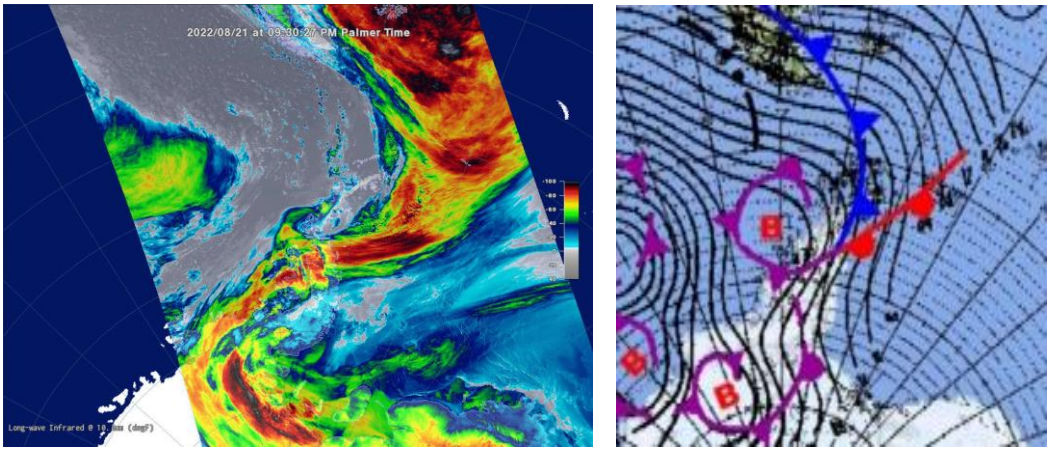

Figure 8. *NOAA-19 August 21st satellite pass (left) explained by the Chilean Navy Meteorological Map (right).*

The imagery was checked daily. Both the METOP and NOAA satellite passes were captured normally.

T-295-P: GPS CONTINUOUSLY OPERATING REFERENCE STATION.

Joe Pettit, Principal Investigator, UNAVCO

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

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

JPL/NASA is contracted to maintain the system, and they have sub-contracted to UNAVCO. While operation and maintenance of the GPS/CORS base station is the responsibility of the Research Associate, it is available for grantees who wish to use the roving systems and/or differential post-processing using data from the fixed reference station. Users are expected to have proper training prior to deployment to Palmer. The Research Associate may offer support to visiting grantees at their discretion.

The system operated consistently throughout the month. The lights on the Trimble and Septentrio receivers were all illuminated in the correct pattern 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 as needed and the monthly log was sent on time. 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 west side of the pier at -64.774558° -64.055580° at a height of 11.46 meters (WGS-84). It was reinstalled at this deeper depth after the completion of the Palmer Pier.

The Research Associate acts as the station's physical oceanography observer by maintaining and observing the sea state. Observations of sea ice extent and growth stage is recorded along with continuous tidal height, ocean temperature, and ocean conductivity.

Observations of sea ice around station were made daily. Tide level, sea water conductivity, and sea water temperature data is archived on the AMRC website: http://amrc.ssec.wisc.edu/data/ftp/pub/palmer/.

Figure 9. *Sea ice in Hero Inlet, August 19. At right is a pair of Weddell seals. Image credit: Ben Rosen-Filardo.*

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. All three remote AWS sites require maintenance so their functionality this season were sporadic at best. One minute weather data is archived on the AMRC website: http://amrc.ssec.wisc.edu/data/ftp/pub/palmer/.

Monthly Weather Synopsis

August 2022 was the warmest August on record (1997 – present), with an average temperature of -1.2°C / 29.9°F. In addition, August's minimum temperature of -6.3°C / 20.7°F was the highest on record (1989 – present). The sea surface temperature also broke an August record (2015 – present), with an average temperature of -1.3°C / 29.7°F.

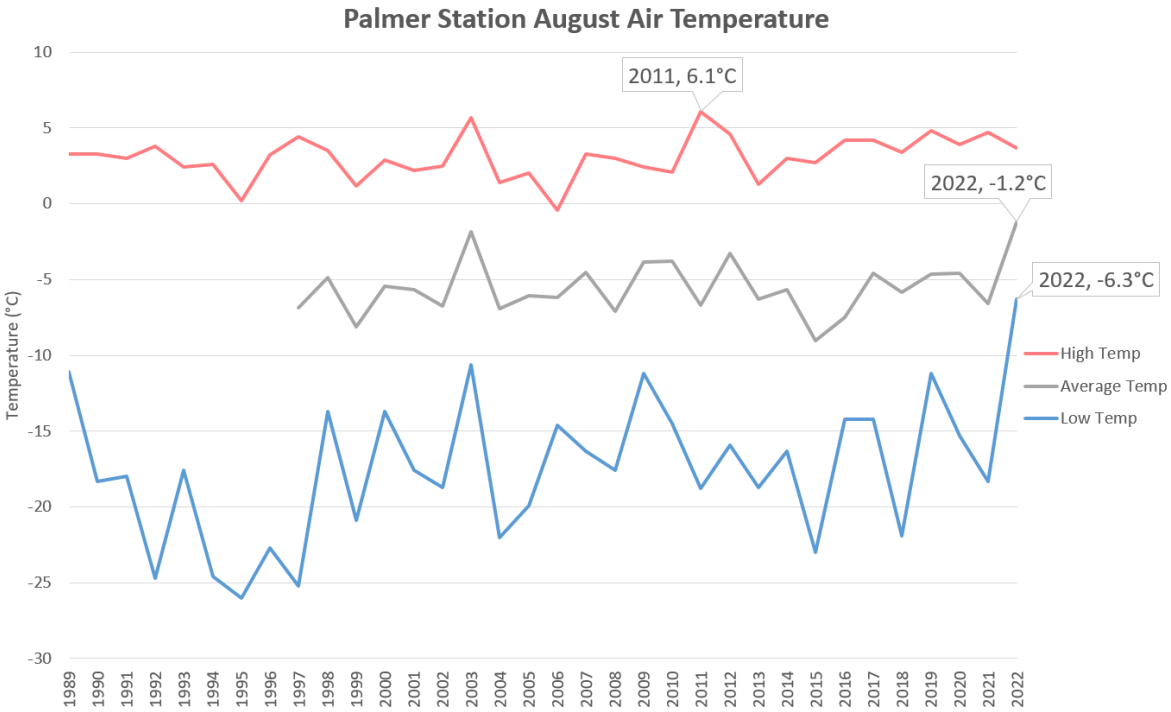

Figure 10. *Palmer Station August air temperature data, 1989-present.*

August was also stormier than usual, with 89 mm of melted precipitation, 73 cm of snowfall, and an average wind speed of 17 knots.

Palmer Monthly Met Summary for August 2022

Temperature
Average: -1.2 °C / 29.9 °F
Maximum: 3.7 °C / 38.66 °F on 31 Aug 01:45
Minimum: -6.3 °C / 20.66 °F on 26 Aug 12:35
Air Pressure
Average: 986.9 mb
Maximum: 1015 mb on 4 Aug 10:03
Minimum: 949.2 mb on 25 Aug 03:23
Wind
Average: 17.4 knots / 20 mph
Peak (5 Sec Gust): 65 knots / 75 mph on 21 Aug 21:26 from NNE (12 deg)
Prevailing Direction for Month: NE
Surface
Total Rainfall: 88.9 mm / 3.5 in
Total Snowfall: 73 cm / 28.5 in
Greatest Depth at Snow Stake: 110.8 cm / 43.2 in
WMO Sea Ice Observation: 6-10 bergs, bergy bits, growlers, grease, shuga, pancake ice, and brash ice
Average Sea Surface Temperature: -1.3 °C / 29.7 °F