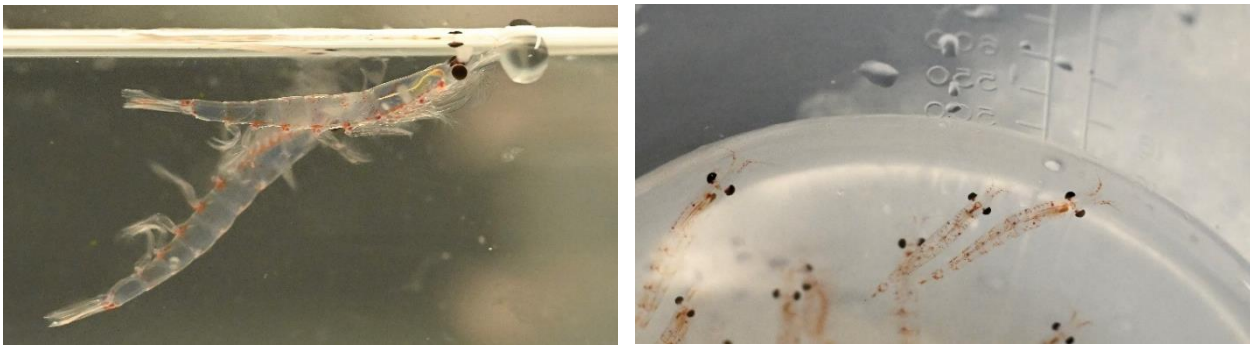
PALMER STATION MONTHLY SCIENCE REPORT

July 2022



Krill from Palmer Station's "Omnivore's Dilemma" study. *Image Credit: Shawn Wilson.*

NEWS FROM THE LAB
Angela Klemmedson, Winter Laboratory Supervisor

A monthly average temperature record was set in July, showing warmer than normal temperatures for this time of year. See Monthly Weather Synopsis within this report for more information.

All science operations were conducted as planned and successfully accomplished. Our group of overwintering scientists – the krill group working on the "Omnivores Dilemma" study – kept busy preparing for the upcoming World Krill Day, on top of completing Time Point 2 of their experiments.

This will be the inaugural World Krill Day, initiated by the Antarctic and Southern Ocean Coalition. Dr. Kim Bernard has been working with Pew Charitable Trust and the National Science Foundation on outreach efforts that will contribute to the event. In honor of this exciting new awareness day, this month's science report introduction will focus on krill, provide background information on their ecological importance, and introduce the event that will be hosted next Thursday, August 11th from Palmer Station.

Krill are an order of crustaceans that includes 86 species worldwide, however, the term "krill" is often used to describe one species of krill – Antarctic krill (*Euphausia superba*). This species of krill lives in the Southern Ocean and is relatively larger than other krill species in terms of both body length and total biomass. Antarctic krill (hereafter, "krill") grow to roughly 6 cm in length (about the size of your pinky finger). This is much larger than other krill species, which grow to an average length of only 1-2 cm. Krill are also thought to be one of the most abundant species on the planet in terms of biomass, estimated to be about 500 million tonnes.

This enormous biomass supports the crucial role krill play in ecosystems and biogeochemical cycling. Krill are central to the Southern Ocean food web, and are considered a keystone species. They feed predominantly on diatoms and other phytoplankton, and even on small zooplankton including copepods and amphipods. In turn, most Southern Ocean predators eat krill – or at least eat another species that eats krill. The many species of penguins, seals, whales and larger fishes that occupy Antarctic waters largely depend on krill for survival. In addition to their important role in the food web, krill are able to move large amounts of carbon to the seafloor. They do this

by consuming large amounts of phytoplankton at the ocean's surface and excreting fecal pellets that sink through the water column. This sinking is facilitated by the fact that krill make daily vertical migrations and often excrete fecal pellets beneath the thermocline, which is difficult to permeate. This ecosystem service helps to mitigate climate change by converting atmospheric carbon to carbon sinks on the sea floor.

Because of krill's importance to ocean food webs and role in global carbon export, their conservation is imperative. Krill populations may be affected by commercial fishing and impacts from climate change. With proper management and conservation efforts, however, we can make sure that their populations will persist, and continue to support higher predators and sequester carbon to the deep ocean. Thanks to organizations like the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), there are global efforts to manage krill populations and the Southern Ocean ecosystem. However, it is also important to increase awareness about krill and help the public to understand why we should care about their conservation and effective policymaking.

World Krill Day is intended to help bring awareness to this fantastic crustacean. There are many reasons to love this adorable creature and appreciate the ecosystem services it provides. To participate, please register using the following link: **https://bit.ly/3O9s7cN** and then join us on August 11th for a live presentation from Palmer Station, given by Dr. Kim Bernard and her research team. The presentation will provide background information about krill, describe Dr. Kim Bernard's research, and it will be followed by a Question & Answer period. Looking forward to seeing you there!

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: We conducted Time Point (TP) 2 from July 18th to 25th. During this time point, we ran one growth, one ingestion/egestion, three respiration experiments, and collected 120 krill to measure lipid, protein, and CHN contents. To date, there has been no significant difference in daily growth rates (DGR) across time points or between tanks ($p > 0.05$, one-way ANOVAs). Despite this, we did observe positive growth more frequently in krill from the DIA tank (krill supplemented with a diatom diet), whereas growth in the other tanks was primarily negative (Figure 1.A). Inter-molt period (IMP) was significantly higher ($p = 0.0373$) during TP1 (~90 days) than TP 2 (~23 days), which indicates an increased molt frequency between June and July (Figure 1.B). This change was evident even in krill from the NAT tank (those krill not supplemented with additional food). Respiration rates were significantly lower in TP1 than in either TP0 ($p = 0.005$) or TP2 ($p < 0.001$) (Figure 1.C). However, there has been no significant difference in respiration rates between tanks ($p > 0.05$). Average atomic ratios of oxygen to nitrogen (O:N) increased significantly from 21.41 at TP1 to 42.05 at TP2 ($p = 0.021$) (Figure 1.D). O:N ratios of around 8 suggest body protein use only, while those around 24 suggest equal use of body proteins and lipids, and those above 24 are indicative of the use of stored lipids. The average O:N ratios observed at TP0 (mean = 23.18) and TP1 of our experiment suggest krill were using a combination of both body lipids and proteins as a metabolic substrate in late autumn. However, by TP2 (winter), the elevated O:N ratios indicate that krill had shifted towards using lipid stores as the primary metabolic substrate.

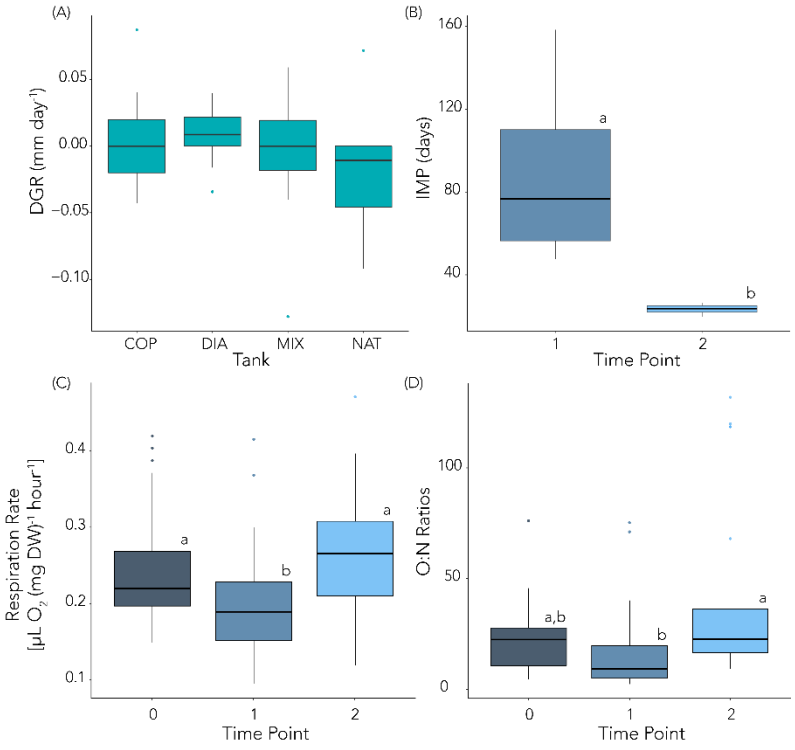


Figure 1. *(A) Mean daily growth rates, DGR (mm day^{-1}) of krill during Time Point 2. (B) Mean inter-molt period (IMP, days) of krill in each tank during Time Points 1 and 2. (C) Mean respiration rates [µL O_2 (mg DW)$^{-1}$ hour^{-1}] of krill from Time Points 0-2. (D) Mean atomic oxygen to nitrogen (O:N) ratios of krill from Time Points 0-2. Significant differences are shown with compact letter display.*

Outreach: As of 07/31/2022, the 19 short videos about our research and life in the field that are posted on Instagram and Twitter (both @psycho_kriller) have received a total of 20,973 views. We are currently preparing for World Krill Day (August 11th). We will be conducting a live video broadcast hosted by the NSF on August 11th at 19:00 US Eastern Time. Kim was invited to write a blog for Pew and was interviewed by Pew for another article. She also was requested to record several answers to a krill quiz that Pew will be hosting. The team has been preparing tweets for NSF's Twitter Takeover that will occur on August 11th.

Looking Ahead: During the next month, we will conduct TP3 and will continue to monitor conditions with the experimental tanks. We will continue processing samples collected during the cruise and those from TP2. We will also contribute to World Krill Day.

RESEARCH ASSOCIATE MONTHLY REPORT
July 2022
Ben Rosen-Filardo

Pancake ice accumulates in Arthur Harbor following westerly winds. *Image credit: Ben Rosen-Filardo*

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.

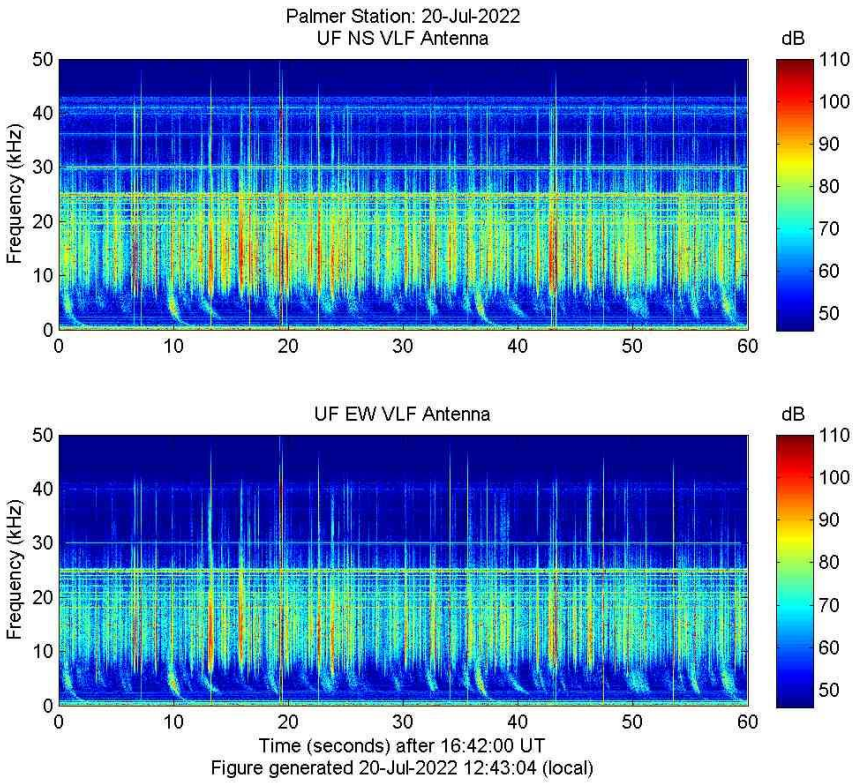


Figure 2. *Real-Time broadband VLF Spectrogram from Palmer Station, Antarctica.*

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 Research Associate 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.

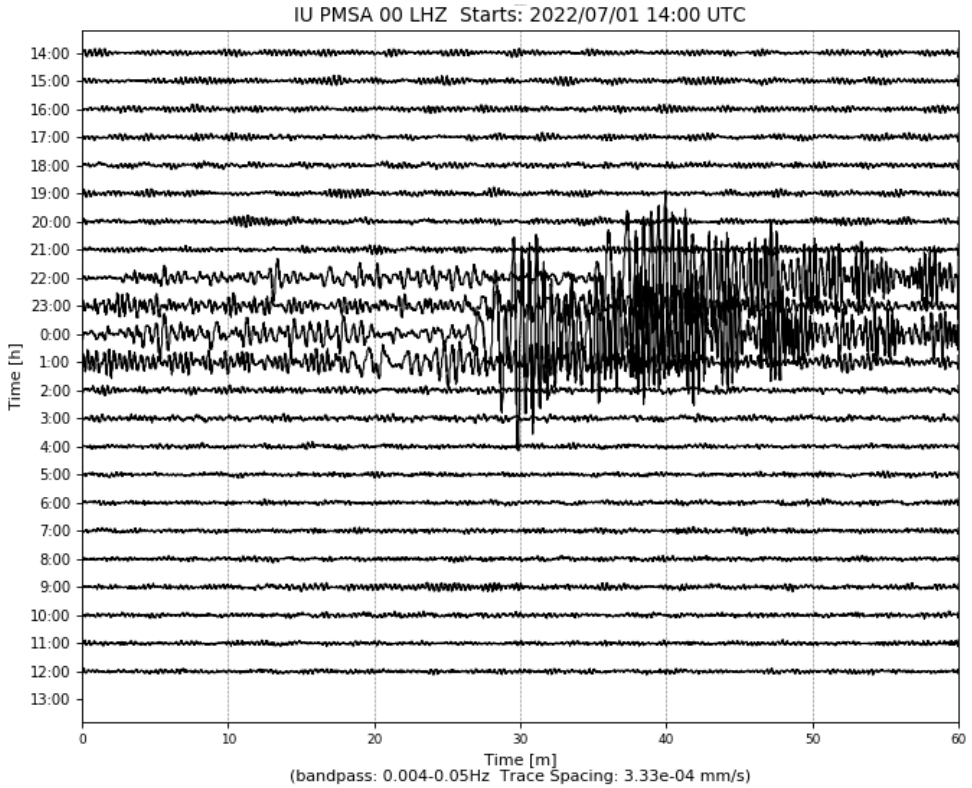


Figure 3. *A 6.1 magnitude earthquake occurring on July 1, 2022 in southern Iran.*

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 Ocean over time.

The changes in oxygen percentage 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.

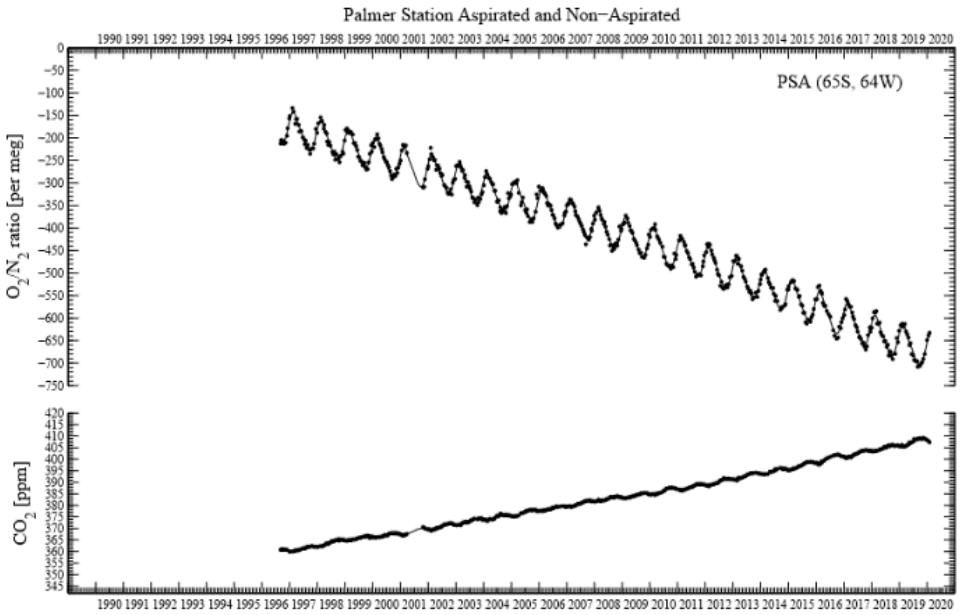


Figure 4. *Historical plot of* $\boldsymbol{O_2/N_2}$ *ratio per meg and* $\boldsymbol{CO_2}$ *ppm updated on July 29, 2020.*

Air samples were collected on July 16 and July 24. 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 July 5, July 11, July 20, and July 26 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/.

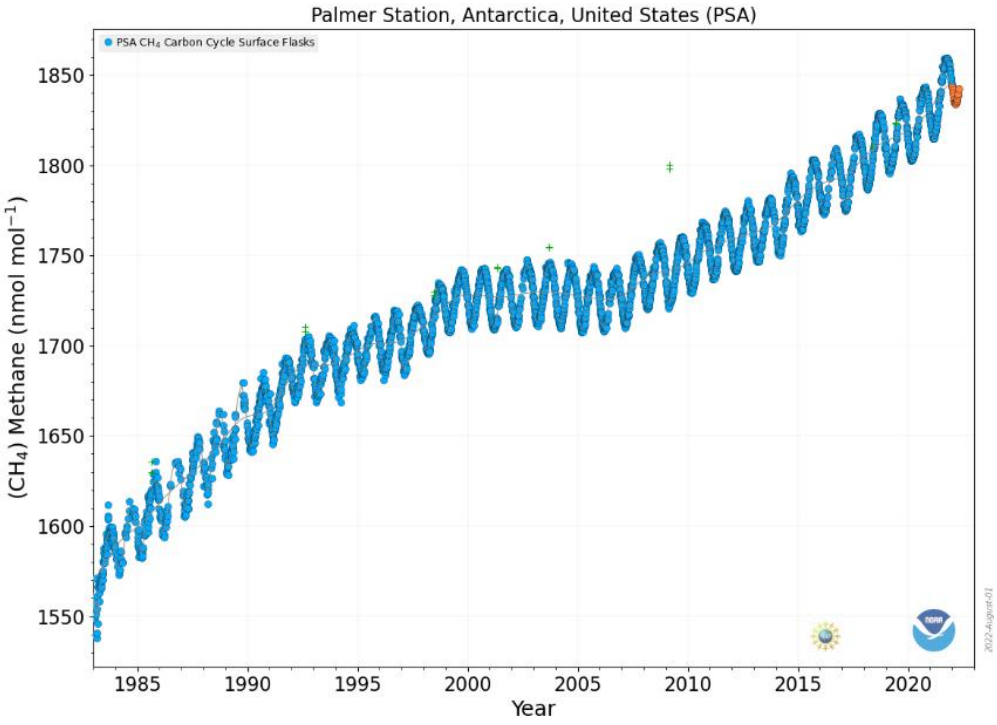


Figure 5. *Methane (CH_4) levels at Palmer Station dating back to 1983. Orange dots are preliminary data.*

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

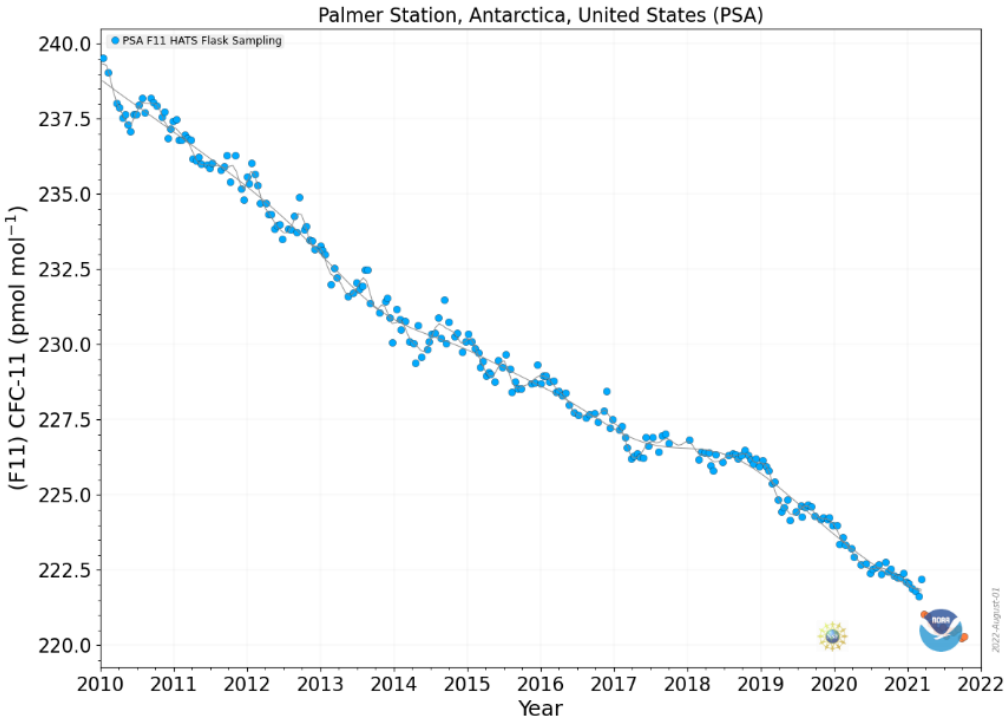


Figure 6. *CFC-11 (CCl_3F) levels at Palmer Station dating back to 2010, one of the Halocarbon and Trace Gases measured at Palmer Station.*

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.

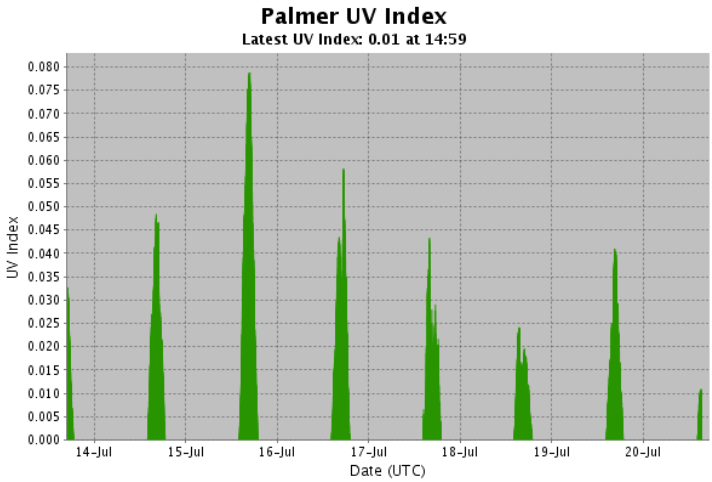


Figure 7. *UV index generated from the GUV-511 radiometer in real time.*

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 July 1, July 15, and July 31 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.

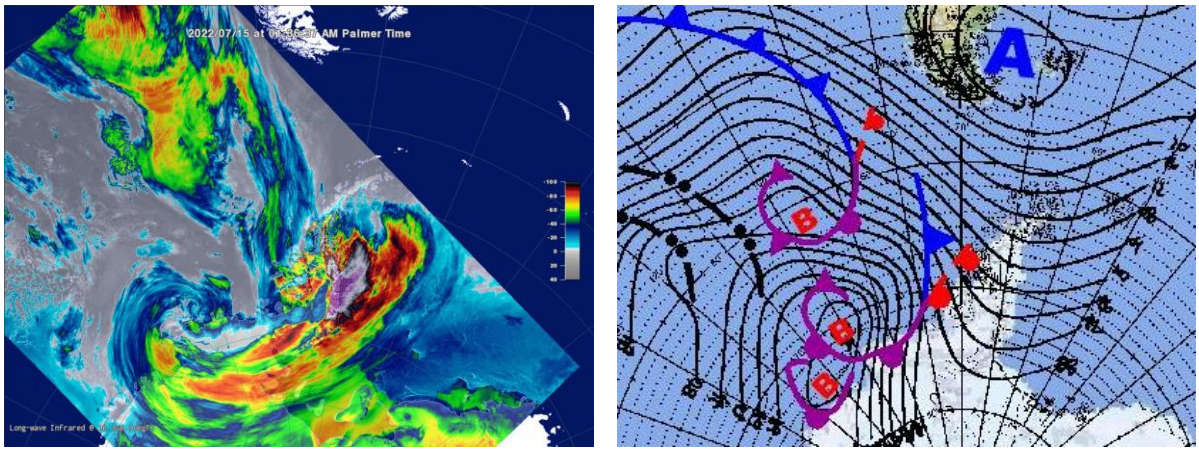


Figure 8. *NOAA-18 Jul-15 satellite pass (left) explained by the Chilean Navy Meteorological Map (right).*

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, Javad, and Ashtech 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: ftp://amrc.ssec.wisc.edu/pub/palmer/tidegauge/.

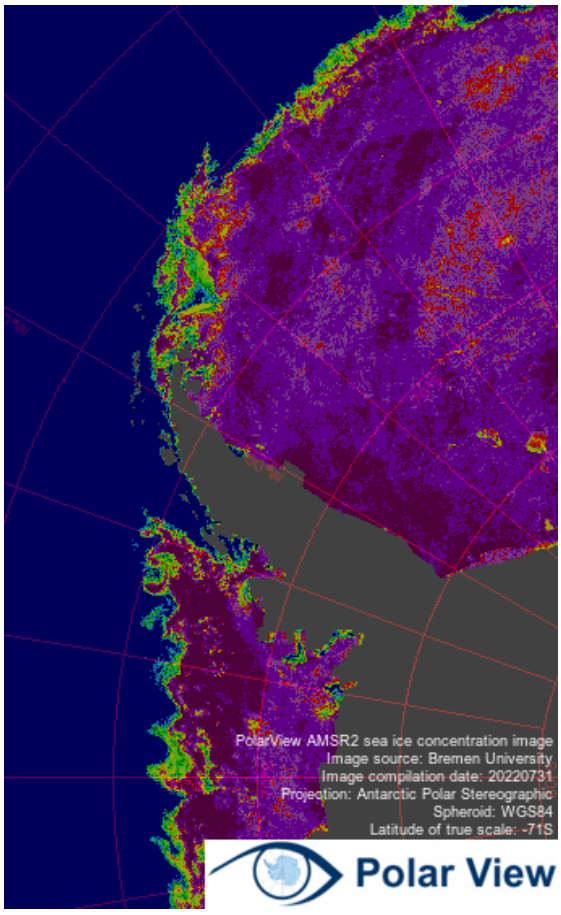


Figure 9. *Polar View AMSR2 sea ice concentration image from July 31.*

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

July 2022 was the warmest July on record (1997 – present), with an average temperature of 27°F. The monthly high temperature of 36°F was reached on July 17. The sea surface temperature also narrowly broke a July record (2015 – present), with an average temperature of -1.3°C / 29.7°F.

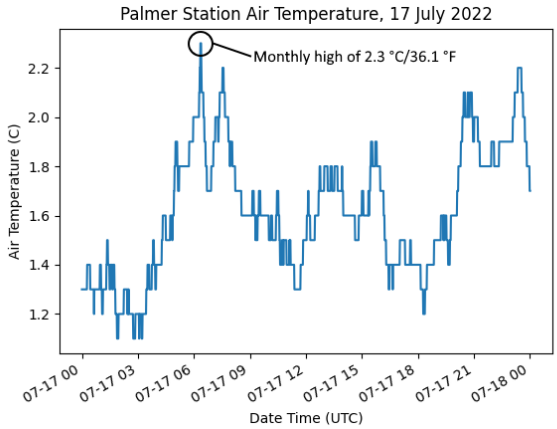


Figure 10. *Palmer Station monthly high temperature, July 2022.*

Palmer Monthly Met summary for July, 2022

Temperature
Average: -2.6 °C / 27.4 °F
Maximum: 2.3 °C / 36.14 °F on 17 Jul 06:23
Minimum: -9 °C / 15.8 °F on 22 Jul 01:59
Air Pressure
Average: 984.5 mb
Maximum: 1014.6 mb on 13 Jul 11:05
Minimum: 954.7 mb on 29 Jul 06:42
Wind
Average: 11 knots / 12.7 mph
Peak (5 Sec Gust): 70 knots / 80 mph on 16 Jul 17:25 from NNE (20 deg)
Prevailing Direction for Month: NNE
Surface
Total Rainfall: 61.2 mm / 2.41 in
Total Snowfall: 30 cm / 11.7 in
Greatest Depth at Snow Stake: 65.8 cm / 25.7 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