

# PALMER STATION MONTHLY SCIENCE REPORT

## SEPTEMBER 2021



Brash and pancake ice ebbed and flowed out of the local boating area, bringing with it some dynamic icebergs throughout the month of September. *Image Credits: Hannah James*

### NEWS FROM THE LAB

Hannah James, Winter Laboratory Supervisor

It is clear to station members that the seasons are shifting. Palmer Station residents have enjoyed more daylight than we've had all season- though we are cautious of the effects of the ozone hole that continues to grow. (See the meteorology section at the end for more information.) With the warming temperatures, the main seawater intake that had frozen earlier in the winter thawed out, and Palmer Station is back on the main seawater intake line.

The final full month of winter was spent wrapping up winter projects in both Bio and Terra Lab and preparing for turnover. Due to the upcoming Palmer Pier construction project, there will be no BioLab staff on site, so much of the laboratory space was put into "lab closed" mode. Instruments were shut down and put away, Polar Haven, Lab Manager, and Station Science Lead offices were packed up to transition into berthing spaces for the summer, and lots of documentation was prepared for how to open spaces up again for the next winter season.



The Lab Supervisor (right) and Station Science Lead offices (left) have been cleaned out and begun their transformation into berthing spaces for the Palmer Station Pier build. *Image credits: Hannah James*

The Research Associate will remain on station and continue to support the science that occurs in and around Terra Lab. The Lab Manager email will remain active, but if you have any questions regarding science at Palmer Station, please reach out to the Peninsula Science & Technical Projects Manager, Jamee Johnson at [Jamee.Johnson.Contractor@usap.gov](mailto:Jamee.Johnson.Contractor@usap.gov). A Lab Manager and Instrument Technician are scheduled to return for the Winter 2022 season. I would like to personally thank Lance Roth for another productive and successful season at Terra Lab, and our supervisor Jamee Johnson for all of the off-site support she continues to provide. Additionally, I would like to extend a warm welcome back to Marissa Goerke, the incoming Research Associate.

The local boating area remained free of sea ice for much of the month, but heavy brash came in and out of both Hero Inlet and Arthur Harbor throughout September. Occasionally a leopard or Weddell seal was spotted lounging on a small iceberg. Kelp gulls, giant petrels, and sheathbills dominated wildlife sightings, though at the end of the month 2 female Weddell seals hauled out on the sea ice deep in Hero Inlet and gave birth to pups.



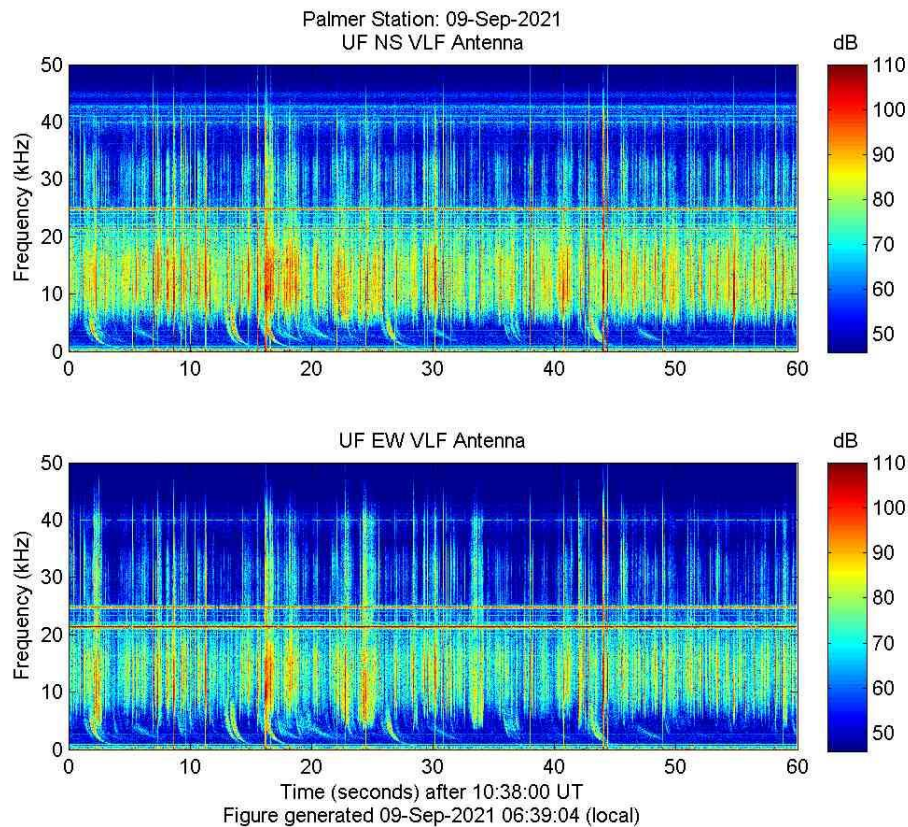
**Weddell Seal pup born deep in Hero Inlet early in October. Image credit: Ken Keenan**

**PALMER STATION  
RESEARCH ASSOCIATE MONTHLY REPORT  
September 2021  
W. Lance Roth**

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

Andrew Gerrard, Principal Investigator, New Jersey Institute of Technology

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



**Figure 1- 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 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](http://halo.ece.ufl.edu/realtime_palmer_nb.php) and  
[http://halo.ece.ufl.edu/realtime\\_palmer\\_bb.php](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 through 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  $0^\circ$  geomagnetic longitude and ranging from  $-5^\circ$  to  $-48^\circ$  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  $0^\circ$  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 27<sup>th</sup>, 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 30<sup>th</sup>, 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 have been collected and are currently in warm storage in Terra Lab. The system is collecting data. 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)

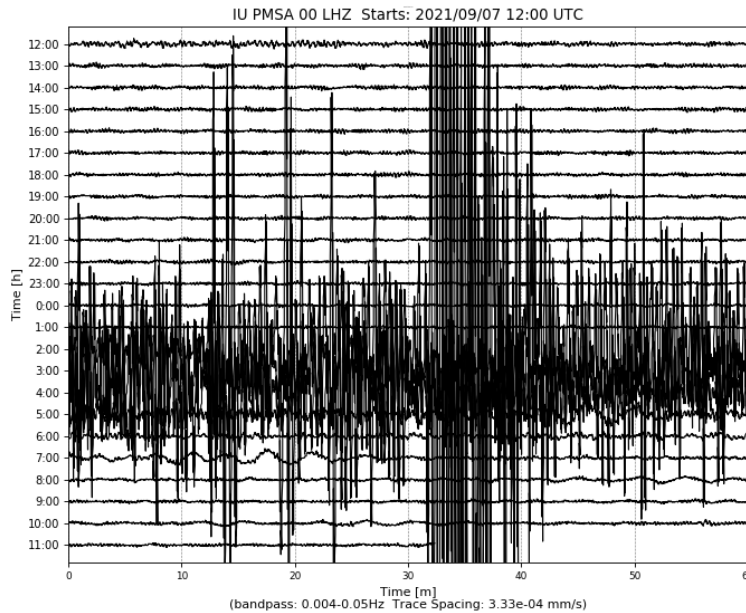
Palmer's seismic station, code named PMSA, is part of the Global Seismic Network (GSN), a collection of 150+ sites worldwide, operating under the aegis of the Incorporated Research Institutions for Seismology (IRIS), and managed by the United States Geological Survey's Albuquerque Seismological Laboratory (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 2- A 7.0 Magnitude earthquake near the coast of Guerrero, Mexico on September 8, 2021**

The system operated consistently throughout the month. The time stamp and seismic activity found on the Heliplot was checked daily. On September 14<sup>th</sup> the Seismic Vault was entered to replace USB Memory, Compact Flash cards, and desiccant. 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<sub>2</sub> (detected through changes in O<sub>2</sub>/N<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> between the atmosphere and the Southern Ocean. The oceans tend to be a source of oxygen to the air in the spring and summer, and a sink for oxygen in the fall and winter. The spring emissions are mostly due to photosynthesis in the water, while the winter uptake is due to mixing process, which bring oxygen depleted waters from depth up to the surface. These exchanges lead to variations in the oxygen content of the air above the water, and these changes are rapidly mixed around the latitude band by zonal winds. Measurements of the seasonal variations in oxygen content at Palmer and other sites may be valuable for documenting changes in the biological productivity of the southern oceans over time.

The percentage changes in oxygen are very small. Relative to the 20.95% background, the summer-winter differences are only about 0.01%. Some special precautions are necessary so that the O<sub>2</sub> 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.

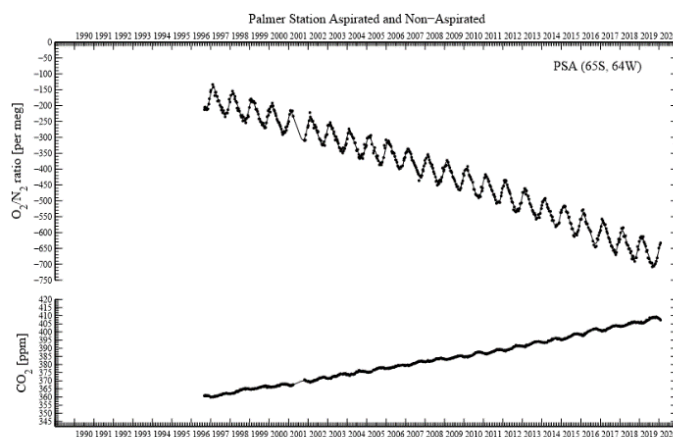


Figure 3- Historical plot of O<sub>2</sub>/N<sub>2</sub> ratio per meg and CO<sub>2</sub> ppm updated on July 29, 2020

Air samples were collected on September 14<sup>th</sup> at 5:00 pm local time and September 29<sup>th</sup> at 9:40 am. 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://scripps2.ucsd.edu/osub2sub-data.html>.

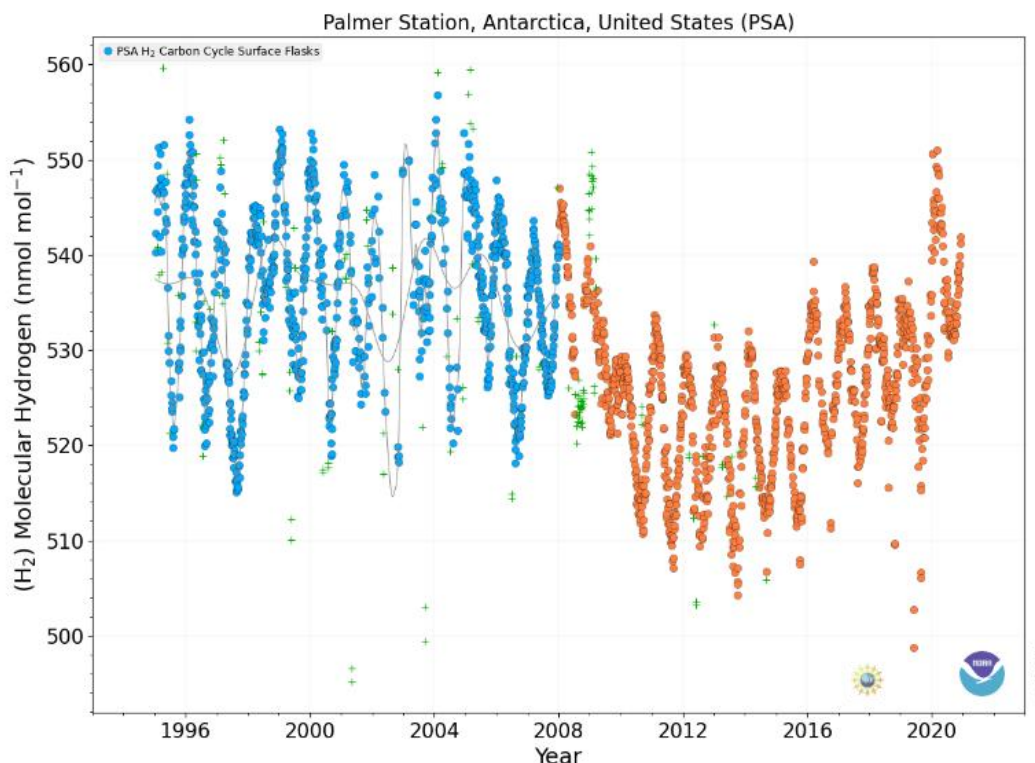
### **O-264-P: COLLECTION OF ATMOSPHERIC AIR FOR THE NOAA/GMD WORLDWIDE FLASK SAMPLING NETWORK**

Don Neff and Steve Montzka, Principal Investigators, National Oceanic and Atmospheric Administration / Global Monitoring Division; Boulder, CO

The NOAA ESRL Carbon Cycle Greenhouse Gases (CCGG) group makes ongoing discrete measurements to document the spatial and temporal distributions of carbon-cycle gases and provide essential constraints to our understanding of the global carbon cycle. The Halocarbons and other Atmospheric Trace Species (HATS) group quantifies the distributions and magnitudes

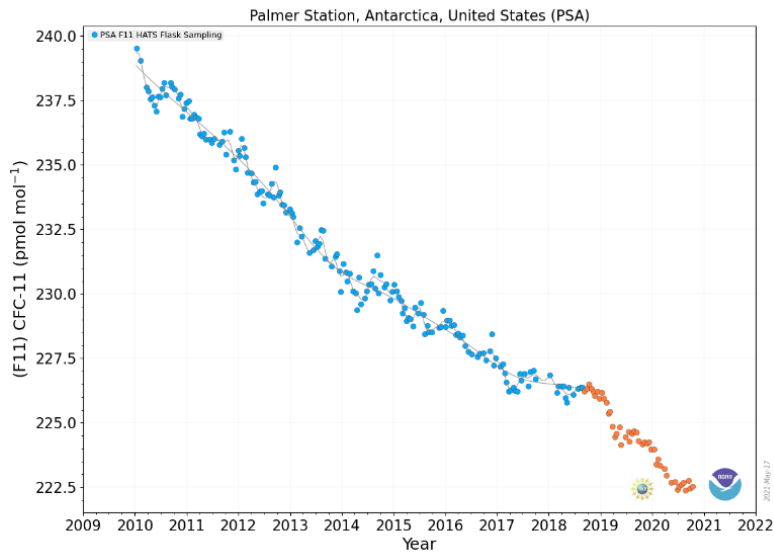
of the sources and sinks for atmospheric nitrous oxide (N<sub>2</sub>O) and halogen containing compounds. The Research Associate collects weekly air samples for the CCGG group and fortnightly samples for the HATS group. Wind must be between 5 and 15 knots and consistently blow from one sector with no people, equipment, or boats upwind of the sampling location.

Carbon Cycle Greenhouse Gases (CCGG) samples were collected on September 1<sup>st</sup> at 1:26 pm local time, September 9<sup>th</sup> at 9:29 pm local time, September 14<sup>th</sup> at 2:51 pm local time, September 23<sup>th</sup> at 10:21 am local time, and September 30<sup>th</sup> at 12:52 local time during favorable wind conditions. More information and data for the Carbon Cycle group can be found at: <https://www.esrl.noaa.gov/gmd/ccgg/trends/>.



**Figure 4- Molecular Hydrogen (H<sub>2</sub>) Levels at Palmer Station dating back to 1995. Orange dots are preliminary data.**

The Halocarbons and other Atmospheric Trace Species (HATS) samples were collected on September 9<sup>th</sup> at 10:37 am and September 23<sup>rd</sup> at 11:22 am local time during favorable wind conditions. You can visit <https://www.esrl.noaa.gov/gmd/hats/> for more information about the Halocarbons and other Atmospheric Trace Species group.



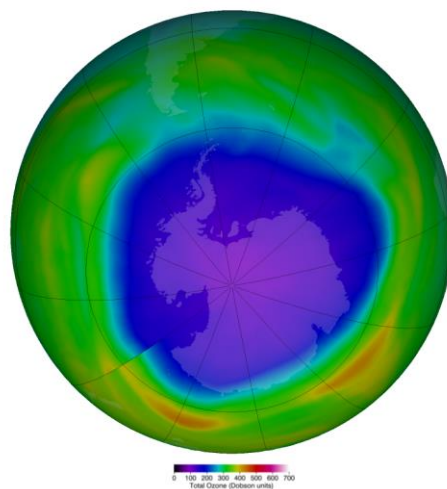
**Figure 5- CFC-11 (CCL3F) Levels at Palmer Station dating back to 2010, one of the Halocarbon and Trace Gases measured at Palmer Station. Orange dots are preliminary data.**

All samples collected on station are sent back to the Earth System Research Laboratories in Boulder, Colorado for analysis.

**O-264-P: ULTRAVIOLET (UV) SPECTRAL IRRADIANCE MONITORING NETWORK**

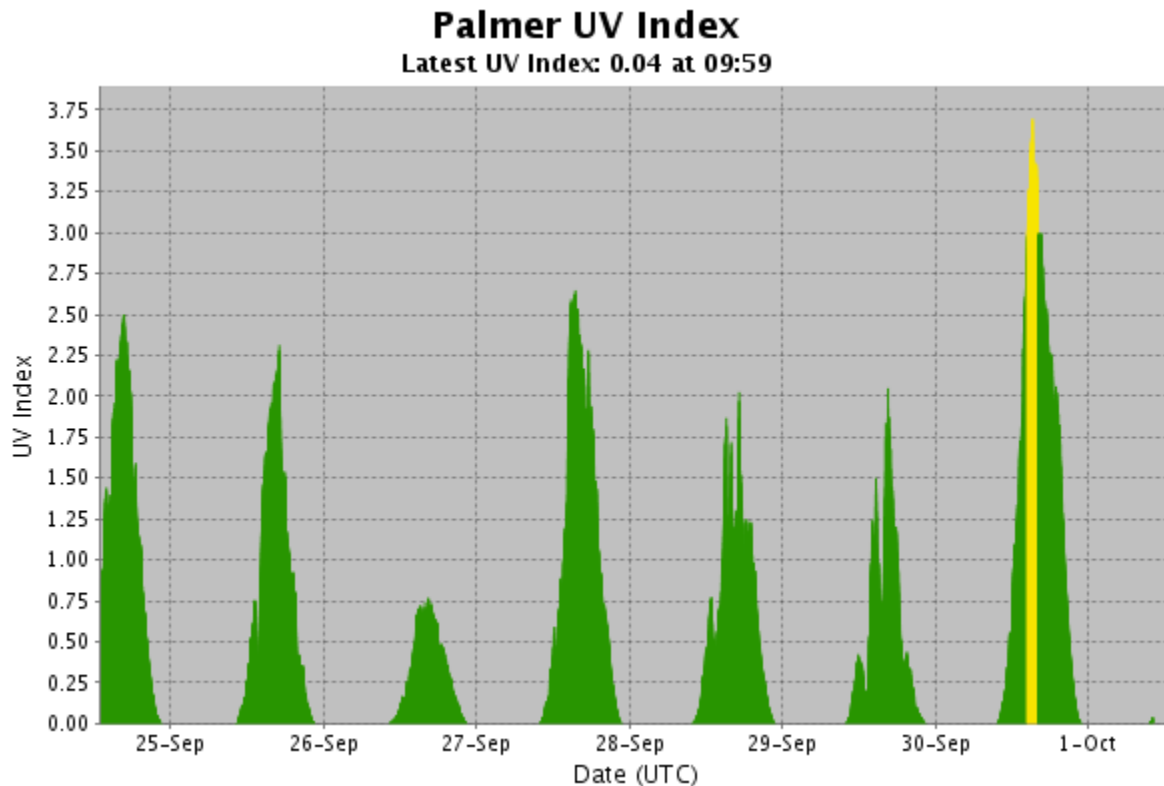
Scott Stierle, Principal Investigator, National Oceanic and Atmospheric Administration / Global Monitoring Division; Boulder, CO

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



**Figure 6- Ozone hole image from 28 September 2021. False-color view of total ozone over the Antarctic pole. The purple and blue colors are where there is the least ozone, and the yellows and reds are where there is more ozone. Image from <https://ozonewatch.gsfc.nasa.gov/>**





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

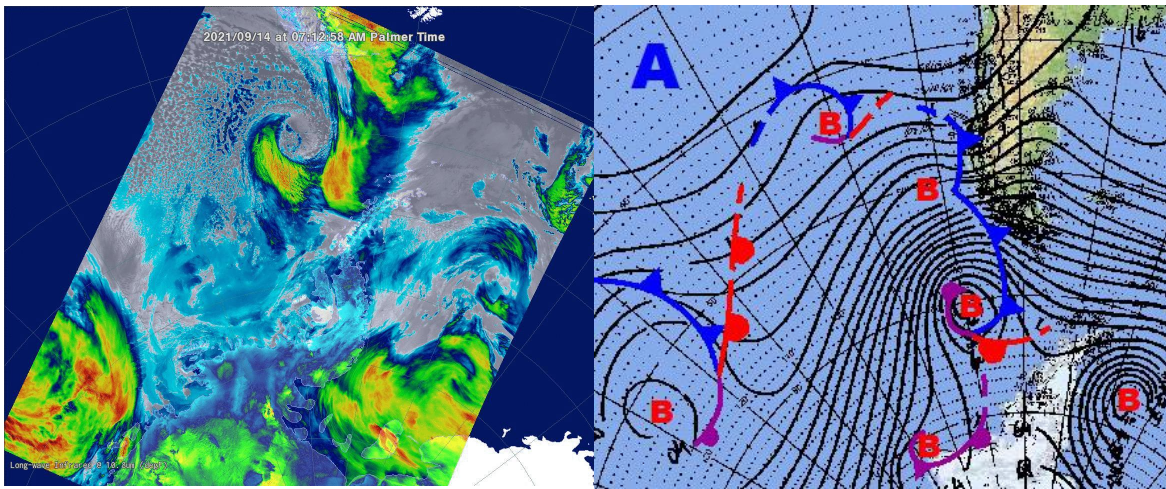
The log was filled out and collectors were cleaned on a daily basis. Once a week level checks were performed to confirm that the instrumentation was within +/- 0.2 degrees. The weekly log was sent out each Monday and a bi-weekly SUV-100 UV Absolute Scan was performed on September 9<sup>th</sup> and September 25<sup>th</sup> as scheduled without issues.

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

#### **R-938-P: TERASCAN SATELLITE IMAGING SYSTEM**

Justin Maughmer, Principal Investigator, System Administrator, United States Antarctic Program

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



**Figure 8- NOAA-19 satellite pass on September 14<sup>th</sup> (left) interpreted by the Chilean Navy Meteorological Map (right)**

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

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

Joe Pettit, Principal Investigator, UNAVCO

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

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

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

The system operated consistently throughout the month. The lights on the Trimble, Javad, and Ashtech Receivers were all illuminated 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](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.

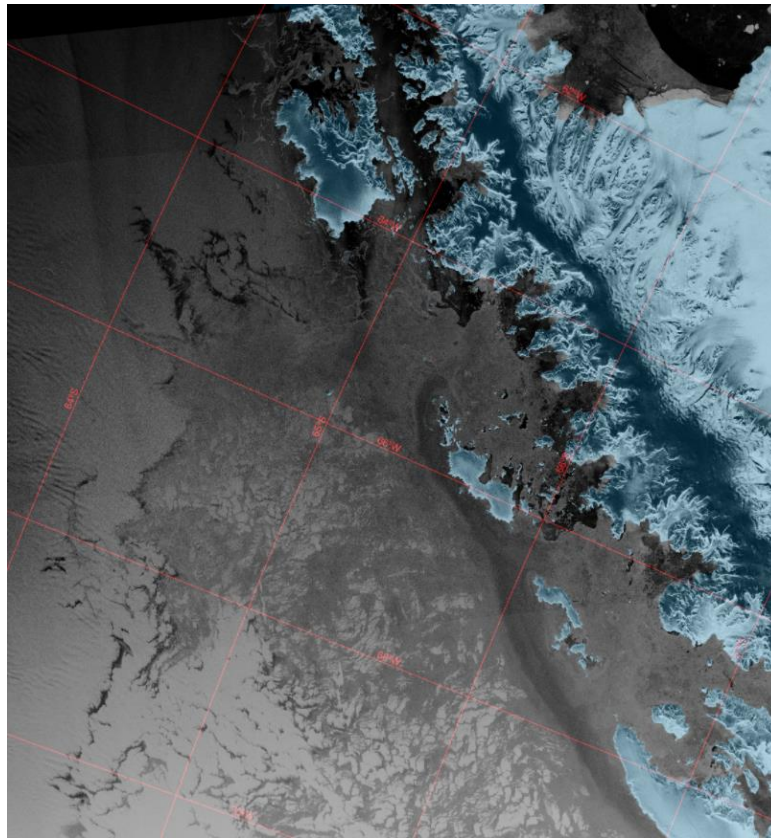
The system operated consistently this month. The RASA GUI was checked daily. The amount of filter material was checked as needed and no anomalies were heard coming from the blower. The anemometer on the roof was removed to troubleshoot. Corrosion was found in the outside connection and one of the pins was compromised. The new rack system was righted in order to maintain the floors. 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 pier at  $-64.774563^{\circ}$   $-64.054837^{\circ}$  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. The tide data was monitored continuously. Tide data is archived on the AMRC website: <ftp://amrc.ssec.wisc.edu/pub/palmer/tidegauge/>.



**Figure 9- Sentinel-1 Satellite image of the ice around Anvers Island on September 23<sup>rd</sup>.**

## **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  $-64.774130^{\circ}$   $-64.047440^{\circ}$  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 should be coming back soon with the increase in the solar angle. One minute weather data is archived on the AMRC website: <ftp://amrc.ssec.wisc.edu/pub/palmer/observations/>.

## Palmer Monthly Met summary for September, 2021

<b>Temperature</b>
<b>Average:</b> -1.8 °C / 28.7 °F
<b>Maximum:</b> 4 °C / 39.2 °F on 22 Sep 17:37
<b>Minimum:</b> -9.9 °C / 14.18 °F on 15 Sep 23:25
<b>Air Pressure</b>
<b>Average:</b> 977.1 mb
<b>Maximum:</b> 1005.1 mb on 7 Sep 12:15
<b>Minimum:</b> 943.5 mb on 29 Sep 13:41
<b>Wind</b>
<b>Average:</b> 17.3 knots / 19.9 mph
<b>Peak (5 Sec Gust):</b> 65 knots / 75 mph on 5 Sep 20:44 from NNE (33 deg.)
<b>Prevailing Direction for Month:</b> NNW
<b>Surface</b>
<b>Total Rainfall:</b> 82.3 mm / 3.24 in
<b>Total Snowfall:</b> 52 cm / 20.3 in
<b>Greatest Depth at Snow Stake:</b> 96.6 cm / 37.7 in
<b>WMO Sea Ice Observation:</b> 6-10 Bergs, bergy bits, growlers, and brash ice
<b>Average Sea Surface Temperature:</b> -1.54 °C / 29.2 °F

## Monthly Weather Synopsis

Repeated occluded fronts passed over the Palmer Peninsula throughout the entire month bringing copious amounts of moisture. These fronts kept our average temperatures around freezing (28.7°F) and on September 22<sup>nd</sup> temperatures surged to almost 40°F. Each moist air mass contributed 20 inches of snow, bringing our total snow accumulation to almost 40 inches and more than 3 inches of rain. This continuous blanket of moist air kept the UV index below 3 during the course of the month even though the Ozone Hole continues to grow larger. One of the characteristics of occluded fronts is high winds which was evident in our average wind speed (20mph) and peak wind speed of 75mph on September 5<sup>th</sup>. Temperatures did drop as low as 14.2°F on September 15<sup>th</sup>. With an average sea surface temperature of 29.2°F, there was some sea ice present for a short period of time.