PALMER STATION MONTHLY SCIENCE REPORT

AUGUST 2020

Thanks to IT support and a faster internet connection, the winter crew has been able to enjoy remote science lectures from a number of grantees this season. Clockwise from the top right: Chuck Amsler at the end of a lecture answering questions, Jim McClintock describing the B-027 Ocean Acidification project, Alison Murray discusses microbiomes found locally around Palmer, and Jim McClintock illustrating Climate Change as seen throughout the Antarctic Peninsula. *Image Credits: Hannah James*

NEWS FROM THE LAB

Hannah James, Winter Laboratory Supervisor

Although Bio Lab remains void of science projects, the month of August flew by at Palmer Station. A number of long-term maintenance projects and inventories are in full swing as preparations for the upcoming LTER summer season continues. Although there are no grantee groups with us personally on station this season, we've been able to connect with a few individuals for remote science lectures thanks to the support from our IT department. Our first month of remote lectures was diving-centered with the B-027/B-236 (Amsler, Baker, McClintock) group presenting during our normal Tuesday evening time slot. It has been wonderful for us at station to re-connect with scientists that have such a history here at Palmer. If you are a grantee who has worked here in the past and are interested in presenting, please email me and we can schedule a time!

With the brevity of previous science monthly reports this winter, our Research Associate Lance Roth has gone a bit further in his descriptions of the year-round science that reside in Terra Lab. We hope you take the time to read about each experiment that the Research Associate maintains throughout the year- there is lots of amazing science that happens in addition to the work done in BioLab and the oceans that draw so many of us to Palmer Station.

Wildlife sightings were more sparse than the previous month: Antarctic terns, cormorants, giant petrels, and snow petrels were each a common sight, a lone Antarctic Petrel was sighted mid-month, and the colony of Gentoos at Point 8 have not been seen for the past few weeks. Elephant and fur seals have become a rare sight.

PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT
August 2020
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 distant.

Both the Extremely Low Frequency and Very Low Frequency systems operated consistently throughout the month. The spectrograms were reviewed daily and bi-weekly antennas inspections were done as weather allowed. Current VLF/ELF data from Palmer Station can be observed at: http://halo.ece.ufl.edu/realtime_palmer_nb.php and http://halo.ece.ufl.edu/realtime_palmer_bb.php.

A-111-P: SAMBA MAGNETOMETER
Andrew Gerrard, Principal Investigator, New Jersey Institute of Technology

The three-axis fluxgate magnetometer at Palmer is one in a chain of 11 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, and the sites are approximately along the 0° geomagnetic longitude and ranging from -5° to -48° geomagnetic latitude. In combination with other magnetometer chains, including the AGO (Automated Geophysical Observatory) systems elsewhere in Antarctica, the stations create an almost complete, cusp-to-cusp-long meridional chain at approximately 0° magnetic meridian

The magnetometer was originally installed at Palmer in 2005, and a replacement installed in April of 2008. In 2017 the project was taken over by Andrew Gerrard. On February 27th 2017 the USAP IT blocked all northbound VPN traffic under a larger umbrella of blocking all northbound Encrypted-Tunnel traffic. Since that time there has been much discussion, but the magnetometer is still a security vulnerability. The Research Associate has been working with the home institution

at the University of California, Los Angeles to resolve this issue. Instructions from the ASC Palmer Science Manager and NSF are for the RA to "keep the system running" but not to make any updates or spend significant time on the project. 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 and so can receive signals from over the horizon. There are CODAR antennas at Palmer (just below Terra Lab near Hero Inlet) and also at the Joubins and the Wauwerman Islands. Each system measures the radial component of ocean wave velocity by transmitting a fundamental frequency at 12 MHz and receiving a reflected signal at twice the fundamental frequency (half the wavelength). By combining the measured velocity components from the three stations, the total wave velocity can be determined. The Doppler shifts of the reflected signals can be used to measure surface currents. Wave velocity can be affected by currents at depths of 1 meter and shallower and thus a measureable with CODAR.

The system operated consistently throughout the month. The computer at the Wauwerman site went down in April, but the Joubins and Palmer sites are still generating data. 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.

The system operated consistently throughout the month. The time stamp and seismic activity found on the Heliplot was checked daily. Current data from Palmer station can be found on the USGS site: https://earthquake.usgs.gov/monitoring/operations/stations/IU/PMSA/#heliplot.

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

Ralph Keeling, Principal Investigator, Scripps Institution of Oceanography

The goal of this project is to resolve seasonal and inter-annual variations in atmospheric O_2 (detected through changes in O_2/N_2 ratio), which can help to determine rates of marine biological productivity and ocean mixing as well as terrestrial and oceanic distribution of the global anthropogenic CO_2 sink. The program involves air sampling at a network of sites in both the Northern and Southern Hemispheres.

The Scripps Institution of Oceanography flask sampling project analyzes air samples to assess variations in the atmospheric oxygen content caused by exchanges of O_2 between the atmosphere and the southern ocean. The oceans tend to be a source of oxygen to the air in the spring and summer, and a sink for oxygen in the fall and winter. The spring emissions are mostly due to photosynthesis in the water, while the winter uptake is due to mixing process, which bring oxygen depleted waters from depth up to the surface. These exchanges lead to variations in the oxygen content of the air above the water, and these changes are rapidly mixed around the latitude band by zonal winds. Measurements of the seasonal variations in oxygen content at Palmer and other sites may be valuable for documenting changes in the biological productivity of the southern oceans over time.

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

Air samples were taken on August 1st at 12:00pm local time and August 14th at 9:40am local time. Wind conditions must equal or exceed 5 knots from a direction between 5° to 205° constantly for over an hour. 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 (N2O) and halogen containing compounds. The Research Associate collects weekly air samples for the CCGG group and fortnightly samples for the HATS group.

Carbon Cycle Greenhouse Gases (CCGG) samples were taken on August 1st at 10:16am local time, August 8th at 10:30am local time, August 14th at 12:18pm local time, August 23rd at 1:50pm local time, and August 27th at 2:30pm local time during favorable wind conditions. The Halocarbons and other Atmospheric Trace Species (HATS) samples were taken on August 9th at 5:55pm local time, and August 23rd at 2:32pm local time while wind conditions allowed. All samples collected on station are sent back to the Earth System Research Laboratories in Boulder, Colorado for analysis. More information and data for the Carbon Cycle group can be found at: https://www.esrl.noaa.gov/gmd/ccgg/trends/. You can visit: https://www.esrl.noaa.gov/gmd/hats/ for more information about the Halocarbons and other Atmospheric Trace Species group.

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.

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. 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 August 13th and August 27th 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.

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, grantees who wish to use the roving systems and/or differential post-processing using data from the fixed reference station are expected to have proper training prior to deployment to Palmer. The Research Associate may offer training and support to visiting grantees at his/her discretion, but there is no positional requirement to do so.

The system operated consistently throughout the month. The lights on the Trimble, Javad, and Ashtech Receivers were all illuminated and showed no signs of interruption. More information can be found at the following website: https://www.unavco.org/projects/project-support/polar/base_stations_and_survey_systems/palmer/base.html.

T-998-P: INTERNATIONAL MONITORING STATION (IMS) FOR THE COMPREHENSIVE NUCLEAR TEST BAN TREATY ORGANIZATION. (CTBTO)
Managed by General Dynamics

The Comprehensive Nuclear Test Ban Treaty (CTBT) bans all nuclear explosions. Although not ratified, the U.S.A. is following through with the treaty, including the installation monitoring stations around the world. The global verification regime for monitoring compliance is called the International Monitoring System (IMS). The radionuclide air particulate sampling station was installed at Palmer in October of 2005. Palmer's radionuclide sampler/analyzer (RASA) is a primary station in the IMS, known by its treaty code USP73 (and RN73). The pre-existing USGS seismic system is an auxiliary station, treaty code AS106.

Data collected by Palmer's RASA unit is relayed real-time via a virtual private network (VPN) across the Internet back to the CTBT Organization (CTBTO) in Vienna. As of August 2006, both the RASA and seismic systems have been certified by CTBTO. Palmer is now officially part of the IMS. The automated RASA continually filters ambient air and tests for particulates with radioisotope signatures indicative of a nuclear weapons test. The Research Associate operates and maintains the instrument.

The system operated consistently this month. The RASA GUI was checked daily. The amount of filter material was checked as needed and no anomalies were heard coming from the blower. On August 4th the Mylar and sealing tape rolls were changed as per the procedure USP73-RASA-012 "Mylar and Sealing tape Changing.doc" found in the CTBT procedures. Daily filters were

processed and the monthly log was sent as needed. Additional details about the treaty and monitoring stations can be found on the CTBTO web site, http://ctbto.org/.

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. This location better represents the wind by eliminating wind shadows such as the Bio Building and the ARSV *Laurence M. Gould* when it is at the pier. Also, the sensors aren't affected by the sea salt spray, which was a problem in the past. 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.

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 1st of the month for archiving and further distribution.

The local weather station (PAWS) was interrupted by the occasional rime ice on the tower throughout the month. Clear and sunny days allowed the remote weather stations to wake up intermittently and provide data. One minute weather data is archived on the AMRC website: ftp://amrc.ssec.wisc.edu/pub/palmer/observations/.

PHYSICAL OCEANOGRAPHY

Palmer Station has a tide and conductivity gauge located on the pier at -64.774563° -64.054837° at a height of (base datum): 12.13 meter . It was installed in 2018 as the previous location was not adequate for tide or temperature measurements.

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

Observations of sea ice around station were made daily. The tide data was monitored continuously and issues with software restarts associated with the Wednesday night station-wide reboots have been resolved. Tide data is archived on the AMRC website: ftp://amrc.ssec.wisc.edu/pub/palmer/tidegauge/.

AUGUST 2020 WEATHER
Lance Roth, Research Associate

Temperature
Average: -4.6 °C / 23.7 °F
Maximum: 3.9 °C / 39.02 °F on 4 Aug 04:45
Minimum: -15.3 °C / 4.46 °F on 31 Aug 10:59
Air Pressure
Average: 987.2 mb
Maximum: 1007.6 mb on 30 Aug 22:57
Minimum: 968.7 mb on 4 Aug 07:46
Wind
Average: 12.9 knots / 14.8 mph
Peak (5 Sec Gust): 72 knots / 83 mph on 19 Aug 13:18 from NNE (33 deg.)
Prevailing Direction for Month: NNE
Surface
Total Rainfall: 21.3 mm / 0.84 in
Total Snowfall: 30 cm / 11.7 in
Greatest Depth at Snow Stake: 65.4 cm / 25.5 in
WMO Sea Ice Observation: 6-10 Bergs, bergy bits, growlers, brash, grease ice, and ice rind
Average Sea Surface Temperature: -1.47 °C / 29.4 °F

August started out warm, wet, and windy, creating slippery access to buildings and a loss of over three inches of snow. Temperatures reached a high of 39.2°F on August 4th but quickly cooled averaging 23.7°F for the entire month. The warm temperatures at the beginning of the month changed our precipitation to rain accumulating almost an inch on August 3rd. The wind continued to prevail all month with an average speed of 14.8 mph and peaking with a five-second gust of 72 mph on August 19th. Even with the early snow loss, a total of 11.7 inches accumulated this month, raising our total snow accumulation to 25.5 inches. The average sea surface temperature continued to remain below freezing at 29.4°F with little to no sea ice present. Most of the ice was of land origin in the form of bergs, growlers, and brash ice, however during the last few days of August, both the wind and temperatures dropped (the month's lowest temperature of 4.46°F on the 31st) allowing young ice (gray, gray-white ice), 10-30 cm thick extending out beyond the two mile boating limit.