PALMER STATION MONTHLY SCIENCE REPORT

JANUARY 2019

B-086-P (van Gestel) grantees in the Palmer "Backyard" measuring carbon flux (Natasja van Gestel at left and Kelly McMillen at right). *Image Credit: Natasja van Gestel*

NEWS FROM THE LAB

Randy Jones, Summer Laboratory Supervisor

At the beginning of the month, we welcomed the ARSV *Laurence M. Gould* back to Station for the start of the month-long LTER research cruise. The Gould brought the arrival of Alicia Purcell of the B-086-P (van Gestel) group; Megan Cimino, Alexandria Dutcher, and Bill Fraser of the C-013-P (Fraser) group; Greg Larsen and Logan Pallin of the C-024-P (Friedlaender) group; Shuai Gu of the C-045-P (Ducklow) group; and Dulcinea Groff, Zhengyu Xia, and Zicheng Yu of the G-094-P (Yu) group.

With a nearly full Station population, research efforts have been going at a full tilt. Collaborative efforts among the groups have resulted in increased cross-disciplinary fieldwork, including marine and terrestrial based efforts. Increasingly, field efforts are traveling farther from Station to the outer island areas (Joubin, Gossler, and Wauwermans Islands) and to the Palmer Canyon, sometimes multiple times in the same week. Many thanks to the Marine Technicians and to all the grantees and community members who helped or contributed to science grantee operations this month.

The month of January was overall fairly chilly, and most of the scant precipitation fell as snow. Only at month's end, did the temperature rise high enough to allow rain. Brash ice was still a substantial presence in the area as a large area of brash ice continued to persist to the south of the Palmer Station region. Winds from the south were able to fill good portions of the standard boating area with brash ice making January boating more dependent on ice conditions than in past seasons. Icebergs have been less present than last season, but glacial calving continued at a rapid pace resulting in a consistent supply of bergy bits, growlers, and brash to Arthur Harbor and the surrounding waters.

JANUARY 2019 WEATHER

Marissa Goerke, Research Associate

Palmer Monthly Met summary for January, 2019

Temperature
Average: 1.2 °C / 34.2 °F
Maximum: 5.4 °C / 41.7 °F on 28 Jan 17:35
Minimum: -3.2 °C / 26.2 °F on 4 Jan 04:38
Air Pressure
Average: 980.5 mb
Maximum: 993.2 mb on 8 Jan 15:03
Minimum: 963.9 mb on 24 Jan 18:21
Wind
Average: 5.9 knots / 6.8 mph
Peak (5 Sec Gust): 46 knots / 53 mph on 24 Jan 13:57 from ESE (111 deg)
Prevailing Direction for Month: NNW
Surface
Total Rainfall: 21.8 mm / 0.9 in
Total Snowfall: 5.0 cm / 2.0 in
Greatest Depth at Snow Stake: 68.0 cm / 26.5 in
WMO Sea Ice Observation: No sea ice in sight with 1-5 ice bergs and bergy bits.
Average Sea Surface Temperature: 1.45 °C / 34.60 °F

Temperatures peaked at 41.7° F on 8 January and reached a low of 26.2° F on 4 January. The wind peaked at 53 mph on 24 January and averaged 6.8 mph for the month. The prevailing wind direction for the month was from the north-north-west. We had a few storms move through bringing our monthly snow fall to 2.0 inches and our greatest depth at the snow stakes has dropped to 26.5 inches. Sea ice has been replaced by occasional brash ice accumulating from the glacier or blowing in from the south. There are several large icebergs in the area.

B-086-P: ANTARCTICA AS A MODEL SYSTEM FOR RESPONSES OF TERRESTRIAL CARBON BALANCE TO WARMING

Dr. Natasja van Gestel, Principal Investigator, Texas Tech University

Personnel on Station: Kelly McMillen, Alicia Purcell, and Natasja van Gestel

Our research utilizes a plant productivity gradient along a chronosequence of soils that have become deglaciated at different time points. The locations of our sites with respect to the location of the receding terminus over time in the Palmer "Backyard" is shown in Figure 1. We made this figure available to Palmer Station and it has now been incorporated in the science presentation given on cruise ships by Station Area Manager Bob Farrell and Laboratory Supervisor, Randy Jones.

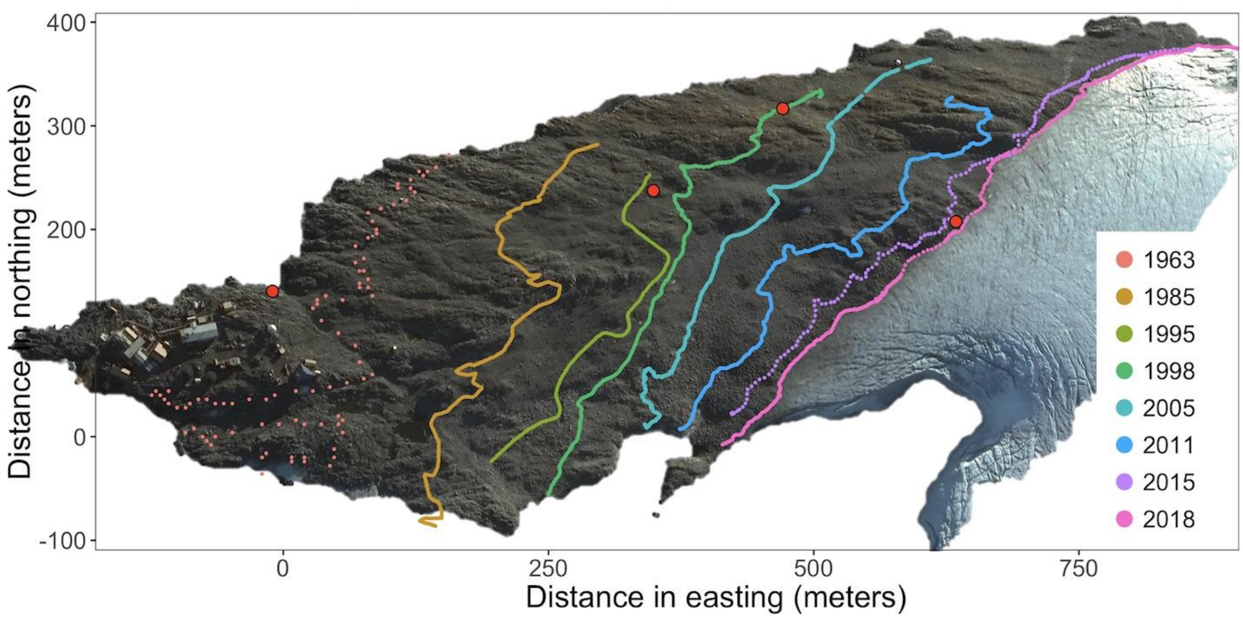

Fig. 1 – Glacier terminus from 1963-2018. The 1963 data were collected more sporadically and thus show as distinct dots. Our four site locations are indicated by larger red dots. Data of the glacier terminus were collected by Palmer Station staff. Satellite imagery © 2018 DigitalGlobe, Inc.

One of our measurements includes the rates of carbon fluxes (in our case, CO_2 uptake by the vegetation through photosynthesis and CO_2 release through respiration). One of the goals of our project is to better understand how carbon fluxes, in particular the net carbon flux, is impacted by warming. To do so, we need good seals between our chamber and our soils. We inserted 12-inch diameter stainless steel in all plots (Fig. 2). These collars will ensure a tight seal when we place our custom flux chamber on them. To minimize disturbance, we will leave these in place until the end of the summer. Additionally, we are collecting continuous data on soil moisture and soil temperature inside each plot (EM50 Loggers with TM5 sensors, Meter Group, Inc., Pullman, WA).

Sites in the Backyard are thus 1-2, 20-23, and 60 years post-deglaciation, in a gradient from glacier edge towards Station. With the inclusion of the highest productivity site at Litchfield (likely deglaciated hundreds or a few thousand years ago), our chronosequence shows a stark pattern in plant productivity gradient (Fig. 2).

Carbon fluxes
The warming treatment using open-top cone chamber was initiated on 2 January in the backyard and 4 January on Litchfield Island. We took carbon flux measurements in all 40 plots before placement of the chambers to get pre-warming values. After two weeks of warming, we began our weekly carbon flux measurements to measure the effect of warming on photosynthesis and respiration by plants and microbes.

Fig. 2 – The plant productivity gradient, from near the glacier terminus (top left), mid-Backyard site (top right), near Station site (bottom left), to Litchfield Island (bottom right).

Microbial growth (using qSIP)
Field incubations to determine microbial responses to warming were initiated on January 6-7 (Fig. 3). The method uses paired intact soil cores. One of the pair receives highly purified water, while the other pair receives water containing a heavier oxygen isotope, oxygen-18. Microbes that are active will use water and the oxygen from the water is incorporated into their DNA. Thus, microbes exposed to heavy water and who are actively growing will have heavier DNA. Using a mathematical growth model, we can then infer growth rates from how much heavier their DNA becomes. This method is called quantitative stable isotope probing (qSIP). To better assess growth rates we are doing a 2-week and a 4-week field incubation.

Soil nutrient availability
We installed Plant Root Simulator (PRS®) probes on 22 January to determine nutrient availability. Probes have specialized membranes that capture *in situ* availability of NO_3^-, NH_4^+,

and PO_4^{3-} for an extended time. These will be replaced in one month's time, so we can assess the soil nutrient status during the height of the summer and late summer.

Fig. 3 – Field incubation of intact soil cores in warmed and control plots. Intact soil samples are inside the stainless steel cores. The soils inside the cores receive either pure water (containing mostly oxygen-16) or heavy water (containing mostly oxygen-18). Microbes that are growing incorporate oxygen into their DNA, so microbes receiving heavy water will have heavier DNA. The density of microbial DNA will be assessed at Northern Arizona University, and sequencing will reveal who are heavier.

Outreach

We engaged with 6th graders from the Sinagua Middle School in Flagstaff on 25 January through a Skype video teleconference. To make the most use of the Skype session, we were able to talk to two classes back-to-back and our collaborator was present in the classroom. We really enjoyed the talk as they asked us very good questions and were eager to learn about the ecology of Antarctica.

I have kept up with my daily blog: https://natasjavgestel.github.io/blog/. The number of blog users increased dramatically from my previous monthly science report, from 107 to 787 users. The number of countries increased concomitantly, from 7 to 23 countries (all seven continents).

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

Dr. William R. Fraser, Principal Investigator, Polar Oceans Research Group

Personnel on Station: Megan Cimino, Alex Dutcher, Bill Fraser, Darren Roberts, and Megan Roberts

The arrival of Bill Fraser, Megan Cimino, Anne Schaffer (LTER cruise participant), and Alex Dutcher in early January briefly increased C-013-P/L personnel at Palmer Station to six. On 5 January, Megan Roberts and Anne Schaffer departed on the annual LTER cruise leaving four bird researchers at Palmer Station for the remainder of January.

We were able to conduct boating field work on 30 days in January. Monitoring of Adélie, gentoo, and chinstrap penguin breeding chronology continued this month with indicator colony counts as well as an all-colony chick census on local islands as well as on Dream and Biscoe Islands. Adélie chick measurements also occurred in conjunction with our LTER cruise team's measurements on Avian Island. Foraging ecology studies of Adélie and gentoo penguins continued this month with the deployment of presence/absence radio transmitters, GPS tags, and dive depth recorders at Torgersen Island, Humble Island, and Biscoe Point. We also began deployments of GPS tags and dive depth recorders on gentoo and chinstrap penguins in the Joubin Islands. We began diet sampling Adélie penguins on Torgersen Island. Gentoo penguin diet sampling began at Biscoe Point and in the Joubin Islands. In total, we were able to deploy a total of 55 tag packages on penguins of all three species. Twenty of those were radio transmitters that are a part of our presence absence study.

Gentoo penguin crèche after chick counts at Biscoe Point *Image Credit: Fraser group*

Skua work continued this month documenting hatches and monitoring chick growth of brown skuas on local islands, as well as on Dream, Biscoe, and Joubin Islands. South polar skua nesting was also documented on Shortcut Island. Monitoring of the blue-eyed shag colony on Cormorant Island also continued this month. In January, we maintained GPS tagging effort on giant petrels and continued our local island giant petrel census and banding project that was initiated in December. Our annual Humble Island giant petrel study began in January which closely records petrel chick survival and growth from hatching through fledging.

Brown skua chick. *Image Credit: Fraser group*

Giant petrel tagged at Elephant Rocks *Image Credit: Fraser group*

Monitoring of marine mammals continued in January with increasing numbers of molting elephant seals as well as an increase of Antarctic fur seals to the Palmer area. We also observed an increase in humpback, and minke whale sightings. Lab work this month was dominated by penguin diet sample processing.

January was a busy month for C-013-P and our field work was only possible due to the efforts and dedication of the ASC personnel. Special thanks to the marine technicians on station for keeping us on the water and moving. Grantees from other LTER groups provided logistical, moral, and scientific support that was invaluable and very much appreciated.

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

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

Personnel on Station: Schuyler Nardelli and Marie Zahn

January was a very productive month for the C-019-P (Schofield) lab! Biweekly sampling at Stations B and E continued successfully throughout the month, showing a large bloom mid-January and season-high chlorophyll and primary production rates at the very end of the month (Figs. 4 and 5). In addition, water temperatures have warmed over the course of the season, and the seasonal mixed layer depth is becoming more well-defined (Fig. 6).

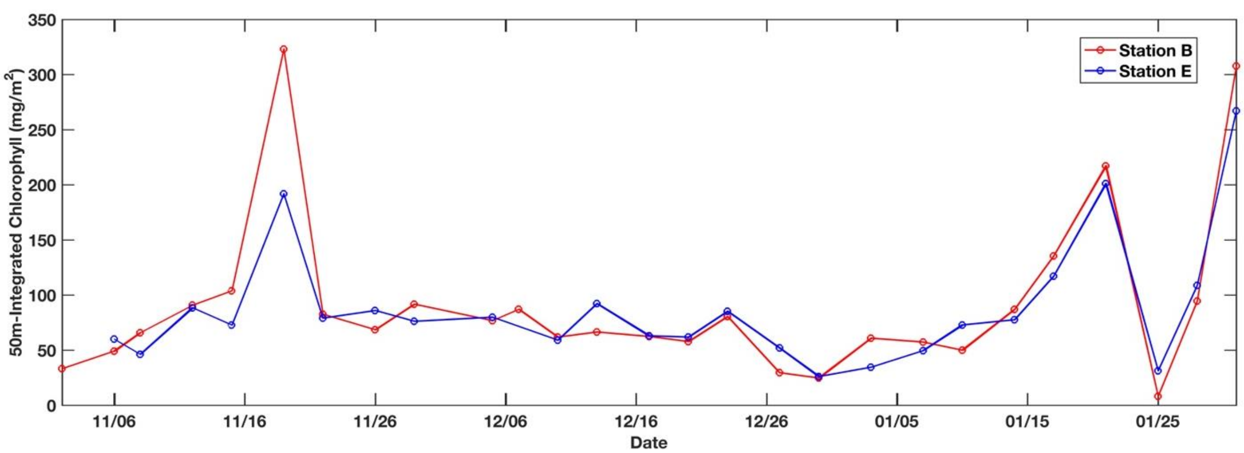

Fig. 4 – Water column integrated chlorophyll (0-50m integrated; mg m^{-2}) values from Station B (red line) and Station E (blue line) for November 2018 through January 2019.

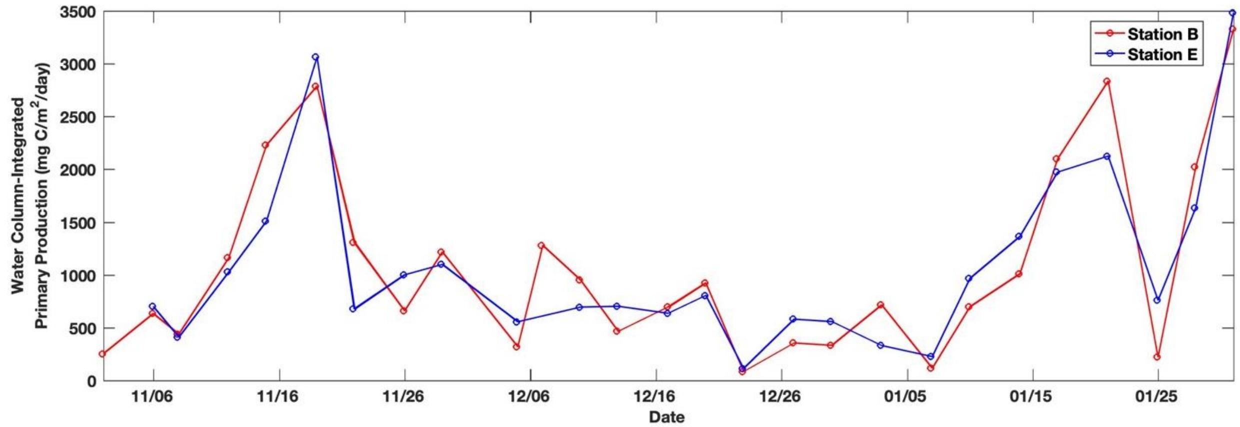

Fig. 5 – Water column-integrated primary production (mg C m^{-2} day^{-1}) values from Station B (red line; 0-50m integrated) and Station E (blue line; 0-65m integrated) for November 2018 through January 2019.

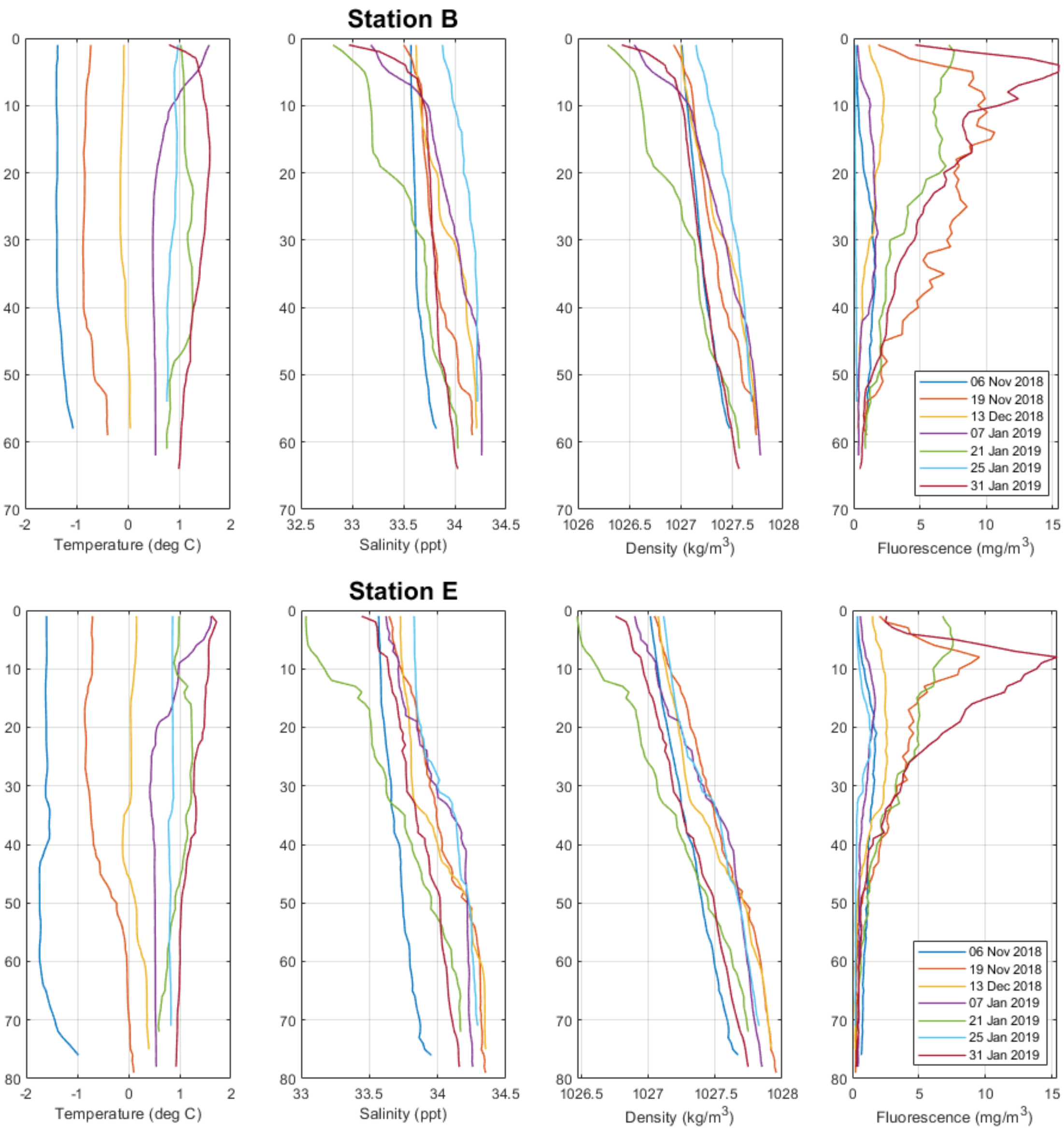

Fig. 6 – Temperature (˚C), salinity (ppt), density (kg m^{-3}), and fluorescence (mg m^{-3}) profiles against depth in meters (L-R) for seven sampling events at Station B (top row) and Station E (bottom row) from November 2018 through January 2019.

This month we also deployed a glider, RU32, from 2-19 January. RU32 was equipped with a CTD; an optics puck measuring fluorescence, optical backscatter, and CDOM; and an Acoustic Zooplankton and Fish Profiler (AZFP) echosounder with three frequencies (38, 125, and 200kHz). The glider transected the Palmer Canyon (Fig. 7B), mapping physical, phytoplankton (Fig. 7C), and zooplankton dynamics (Fig. 7D) in the heart of both gentoo and Adélie penguin

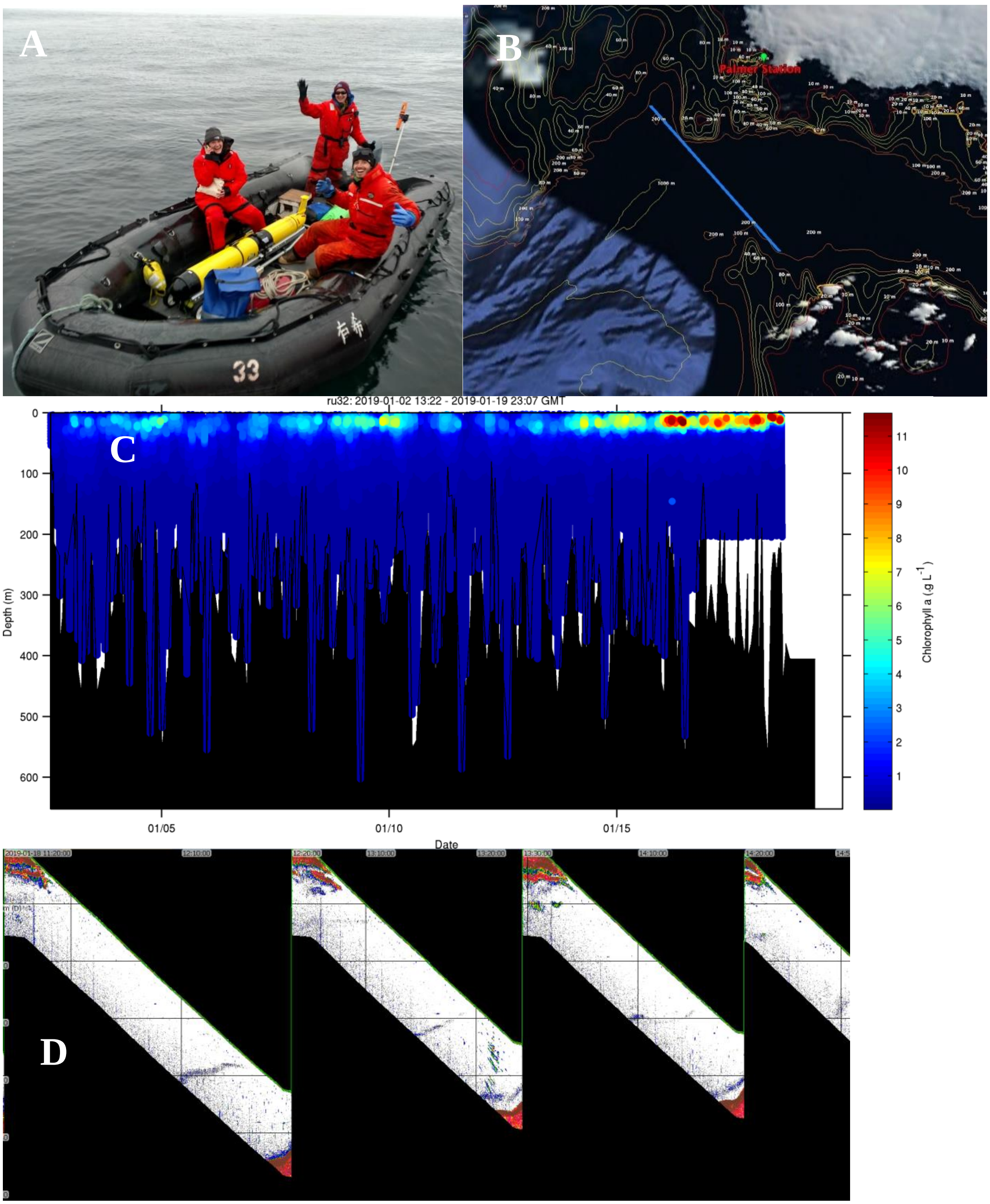

Fig. 7 – (A) Successful recovery of the glider; (B) figure of glider path; (C) chlorophyll (µg L^{-1}) over the course of the deployment, and (D) a snapshot of some of the acoustic data from 125kHz on the AZFP from 18 January 2019, showing large krill swarms in the top 50m.

foraging regions. The glider mission was accompanied by weekly water sampling and net tows to determine what types of phytoplankton and zooplankton were present on the north and south flanks of the canyon, RHIB-based acoustic surveys, and penguin tagging. For more information on the collaborative work conducted between the LTER groups, see C-020-P's (Steinberg) report.

Thank you to ASC for all their support this month. A special thank you to the Marine Technicians for continually going above and beyond to facilitate our sampling outside of the boating limits, and to Laboratory Supervisor, Randy Jones and Instrument Technician, Carolyn Lipke for making sure all our science needs were met!

C-020-P: PALMER, ANTARCTICA LONG-TERM ECOLOGICAL RESEARCH (LTER): LAND-SHELF-OCEAN CONNECTIVITY, ECOSYSTEM RESILIENCE, AND TRANSFORMATION IN A SEA-ICE INFLUENCED PELAGIC ECOSYSTEM – ZOOPLANKTON COMPONENT

Dr. Deborah Steinberg, Principal Investigator, College of William & Mary, Virginia Institute of Marine Science

Personnel on Station: Jack Conroy and Leigh West

2019 is off to a great start! The C-020-P (Steinberg) zooplankton team conducted 101 net tows and spent 18 sampling days on the water in January.

We sampled the Palmer LTER Stations B and E eight times last month. Rapid growth continues to be evident for juvenile Antarctic krill, *Euphausia superba*. However, adult *E. superba* were notably more abundant than juveniles in January, a conspicuous shift compared to earlier this summer. Adult *E. superba* also appeared to enter reproductive maturity in late January. A second krill species, *Thysanoessa macrura*, was abundant in January net tows for the first time this summer.

January time series sampling also revealed shifts in the mesozooplankton community. Herbivorous calanoid copepods (*Rhincalanus gigas* and *Calanoides acutus*) remained dominant, but omnivorous species (*Calanus spp.* and *Paraeuchaeta antarctica*) became more abundant in late January. Last summer, omnivorous calanoid copepods had already started dominating the community by mid-January. Interestingly, larval echinoderms (sea stars) were remarkably abundant in January samples!

We increased our spatial coverage of the coastal Palmer ecosystem throughout January. With the deployment of C-019's acoustic glider, our groups began weekly water and net sampling on the northern and southern flanks of the Palmer Canyon. We conducted five sampling trips to these offshore stations and noted lower mesozooplankton abundance compared to Stations B and E.

We ramped up our survey efforts in seabird foraging regions to coincide with C-013-P's penguin satellite tagging. Along with C-019-P, we completed five surveys in the Gentoo penguin foraging region (between Biscoe Point and the Wauwermans Islands) and three surveys in the Adélie penguin foraging region (head of Palmer Canyon; Fig. 8). These surveys are beginning to reveal clear connections between ocean mixing, phytoplankton and krill distribution, and predator foraging behavior.

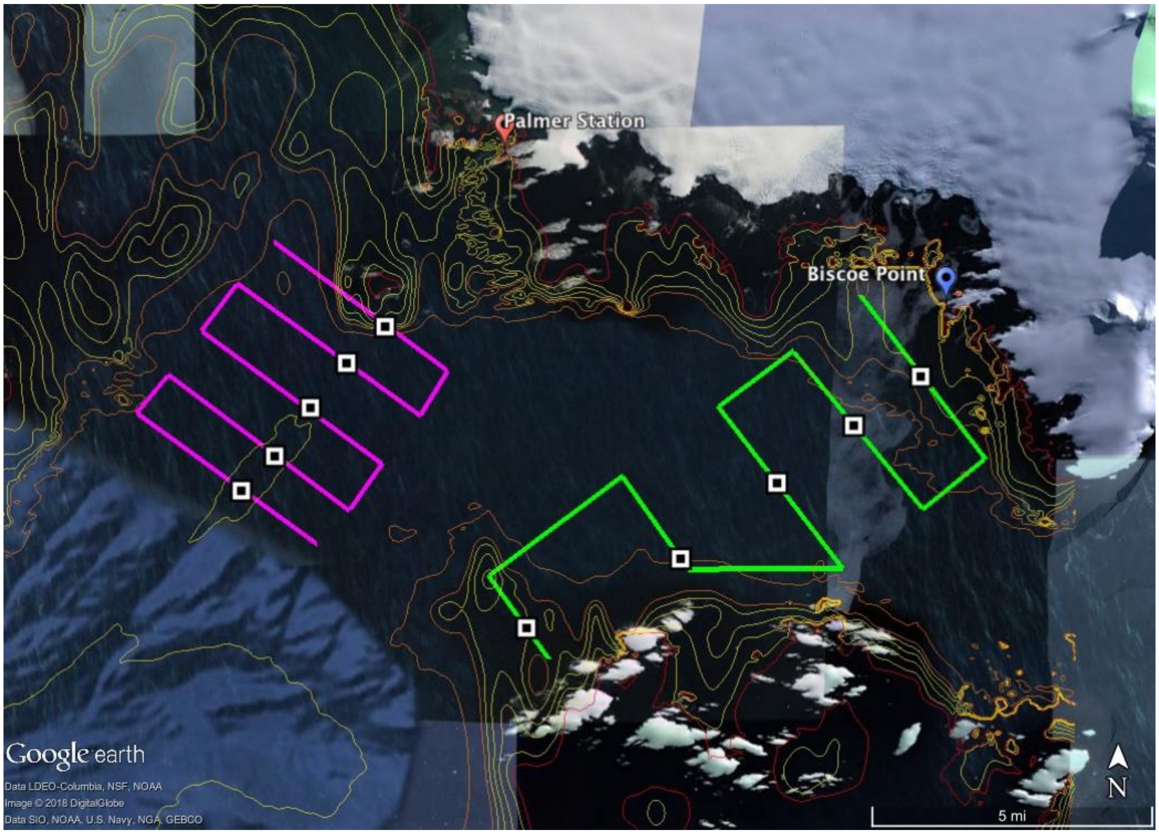

Fig. 8 – Pink and green lines indicate surveys in Adélie and gentoo penguin foraging regions, respectively. Surveys include bioacoustics to map krill distribution and counts of vertebrate predators. Black and white squares indicate CTD sites. Contours indicate bathymetry, courtesy of Josh Kohut.

Finally, we conducted another krill (*E. superba*) feeding selectivity experiment during a January phytoplankton bloom. We are particularly interested in the trophic link between krill and microzooplankton. Preliminary analysis from this experiment supports the possibility that krill selectively fed on microzooplankton and reduced grazing pressure on the phytoplankton community. Further evidence is required to confirm this conclusion and to understand krill-microzooplankton interactions in the natural system, but this was an exciting observation.

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

Dr. Ari Friedlaender, Principal Investigator, University of California, Santa Cruz, Santa Cruz, CA

Personnel on Station: Greg Larsen and Logan Pallin

Whale Survey, Photo-ID, Biopsy Efforts

January was a very productive month for the C-024-P (Friedlaender) group. The main research hypotheses are focused on understanding the ecology and demography of baleen whales in the waters around Palmer Station and the potential for competition among krill predators. The primary objectives are addressed through a combination of visual survey, tissue biopsy collection, photographic ID, UAS measurement, suction cup behavior recording tags, and linking this information to oceanographic parameters (e.g., krill abundance measured with echosounders) and the foraging behavior of local penguins. In addition to the field team at Palmer Station, two additional team members (Michelle Modest and Ross Nichols) are deployed on the ARSV *Laurence M. Gould* to collect similar information at the increased spatial scale of the LTER oceanographic sampling grid.

Daily, we conduct visual surveys in the regular boating area, and utilize the extended boating area when possible to expand our spatial range of observation. During these trips, photo-ID and biopsy sampling are done opportunistically whenever whales are encountered. Starting on 15 January and continuing through 24 January, a large phytoplankton bloom, combined with locally aggregated high densities of krill pushed extraordinary amounts humpback whales into the Palmer Station boating area. On multiple occasions, we witnessed large feeding aggregations of humpback whales on the order of 20-40 individuals, engaging in both surface lunge and bubble net feeding (Fig 9). Logan Pallin and Greg Larsen have spent a total of ~106 hours on the water surveying for whales. In the first 23 days of the field season, they have observed 273 humpback whales, collecting 80 biopsy samples and nearly 115 photo-ID photos of individual whales. They have also observed a total of 24 calves, which have been repeatedly engaging in very active surface behaviors (Fig 10). Never before has our group encountered this many humpback whales this close to Palmer Station for such an extended period of time. We have only observed one other cetacean species, the Antarctic minke whale. We have observed three minke whales this month and collected one tissue sample. On 31 January 2019, we appeared to be experiencing another phytoplankton bloom, as Pallin and Larsen observed another large aggregation of 20-30 whales feeding whales in Wylie Bay.

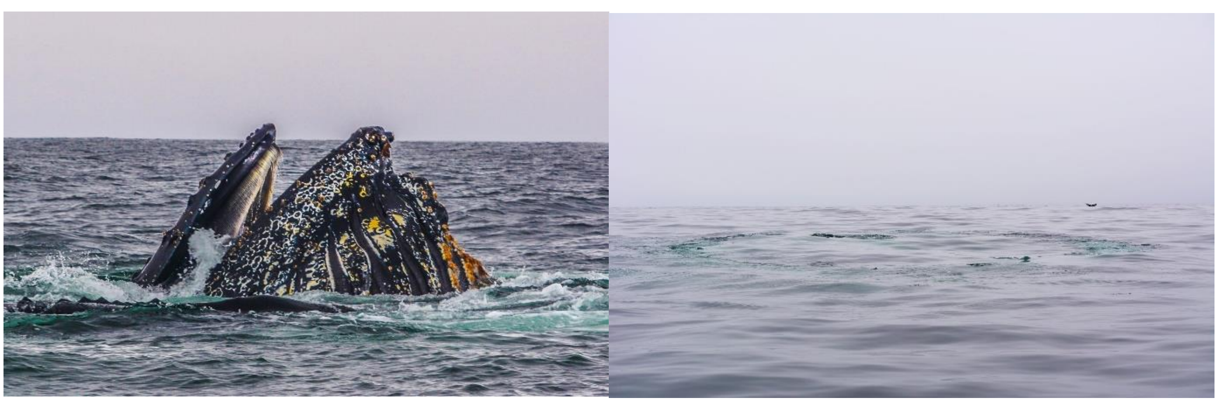

Fig. 9 – Surface lunge and bubble net feeding by humpback whales in Wylie Bay near Palmer Station (Image credits: Friedlaender group).

The biopsy samples will be used for genetic and hormone analyses to assess changes in humpback whale population demography and reproductive rates over time as they recover from commercial whaling. This information will also be linked to interannual variability in environmental conditions to better understand the influence that changes in the timing and extent of winter sea ice have on humpback whales. These samples will also be used in other research projects to test for persistent organo-pollutants and the presence of endocrine disruptors that may indicate exposure to microplastic pollution.

Fig. 10 – Humpback whale calves engage in active surface behaviors including extending their pectoral fins above the water and fully breaching out of the water (Image credits: Friedlaender group).

With the prolonged whale blitz, C-024-P (Friedlaender) have also been working diligently to collect fluke photos that can be used for photo-identification and local residency purposes. For example, they have observed one whale (Mn19_013A_P, Mn19_015I_P, and Mn19_018G_P) on three separate occasions over the course of six days, and recently re-encountered an individual 12 days apart. However, it appears from preliminary analysis that individual humpback whales do not reside in the area around Palmer Station for multiple days at a time (i.e., new whales are seen each day) suggesting that there are far more whales in the general region than are observed at one time. So far, we have collected 115 fluke photos that will be utilized for these purposes (Fig. 11).

Fig. 11 – Fluke photo of humpback whale Mn19_020I_P that will be used for later photo-identification. The linear parallel scars on the right fluke blade are signs of killer whale predation, or what we call “rake marks.” Additionally, the brown coating you see on the fluke is not a skin pigmentation but rather a layer of diatoms (Image credit: Friedlaender group).

For a full set of summary statistics, see Table 1 below. For a summary of humpback whale encounter locations, see the map (Fig. 12) below.

Total Effort Time	105:25:00

	Total Whales Sighted	Total Calves	Total Adults	Full Photo ID
Humpback	273	24	249	115
Minke	3	0	3	
Orca	0	0	0	
Fin Whale	0	0	0	
Unknown	0	0	0	
Totals	**276**	**24**	**252**	**115**

Biopsies Palmer	Total Samples
Humpback	80
Minke	1

Biopsies All Platforms	Total Samples
Humpback	120
Minke	1

Tab. 1 – Field summary statistics for the C-024-P (Friedlaender) whale researcher team stationed at Palmer Station.

Extended boating surveys

The C-024-P team has also completed eight surveys in the "beyond extended" boating area allowing us to cover more ground for surveys. These have included trips to the Gossler and Joubin Islands. Lastly on 23 January 2019, Pallin and Larsen completed their first Palmer Canyon/Wauwermans Islands survey, accompanied by two support vessels (one of which was also collecting critical oceanographic information). This survey proved extremely beneficial and multiple whales were encountered in the canyon area (Fig. 12). This successful trip is a valuable demonstration of the increased capacity now in place at Palmer Station to conduct critical science in a vastly expanded spatial area. This is made possible by the acquisition of the RHIBs and by the effort of the ASC support staff to enable safe and productive research for our and other field teams. For this we are extremely grateful.

Finally, both Logan and Greg contributed to and benefitted from collaborative assistance with ASC personnel and other LTER and NSF funded projects operating at Palmer; the collaboration between and among the projects and staff was evident and helpful and we would like to thank all those who have helped guide and accompany us to whales in the area.

UAS Operations

Following several flights over the first several days at station, the C-024-P team elected to suspend UAS operations when the drone began to manifest navigational difficulties that were not previously seen, or were not seen at such severity, in test and practice flights prior to deployment. Prior to this hiatus, C-024-P was able to gather some UAS-survey data of Hugo Island to complement survey efforts of the C-013-P/L (Fraser) team on 5 January 2019, but no UAS data have been successfully collected since. Some additional hours have been invested to characterize the navigational problem, which appears to concern the compass component, and a replacement component and entire backup UAS are expected to arrive on the next research cruise. We hope to then resume UAS operations in the second half of our field season.

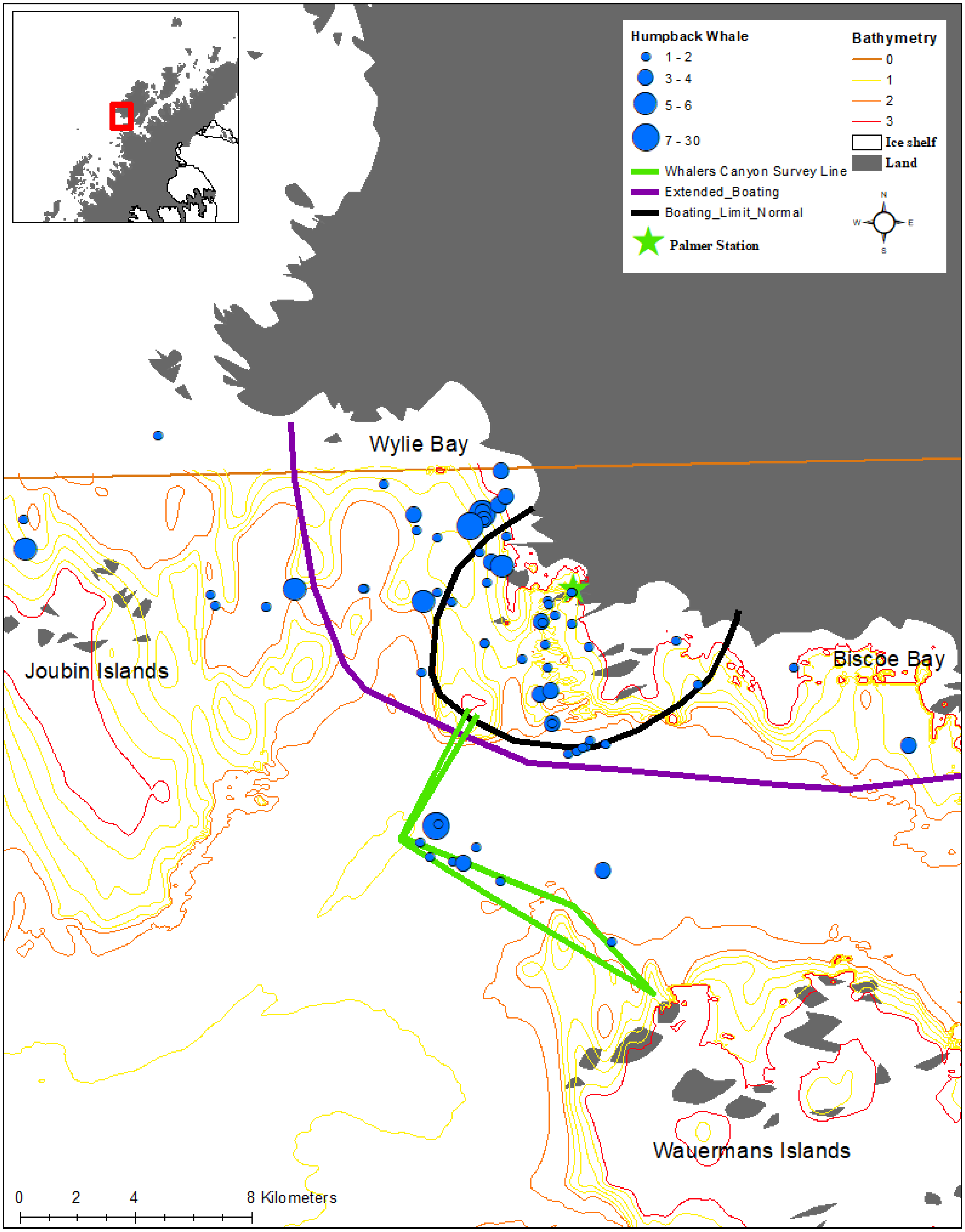

Fig. 12 – Humpback whale sighting locations according to group size (blue circle magnitude).

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

Dr. Hugh Ducklow, Principal Investigator, Columbia University, Lamont Doherty Earth Observatory

Personnel on Station: Shuai Gu, Shawnee Traylor, and Rebecca Trinh

As Rebecca Trinh and Shawnee Traylor shifted onto the LMG19-01 LTER cruise, Shuai Gu has taken over the work of C-045-P at Palmer Station since early January.

Sampling continued at Station B and E every Monday and Thursday. Samples of nutrients, O-18, fixed flow cytometry, and DNA are collected and preserved respectively.

DNA/RNA diel samples were collected every day at mid-day and mid-night from the seawater pump house intake at Palmer Station, to analyze microbial community structures and examine the existence of nitrogen fixation marker genes (e.g., nifH gene). Seawater was filtered using a 0.22 μm PES membrane within 30 minutes. The membrane was then preserved at -80^{o}C after flash freezing in liquid nitrogen.

The EIMS (Equilibrator Inlet Mass Spectrometer) kept running smoothly throughout the month, measuring net community production through O_2/Ar ratio. Beautiful diel cycle signals can be observed most of the time, with higher O_2/Ar ratios during daytime and lower ratios at night. O_2 was always over saturation except for 24-28 January, when deeper water mixed up under the influence of strong wind. These data also corresponded to the chlorophyll concentrations.

In the meantime, Gu set up the FARACAS (Flow-Through Incubation Acetylene Reduction Assays by Cavity Ring Down Laser) system in the aquarium room (Fig. 13); an instrument that continuously measures nitrogen fixation rate in the surface seawater. Some troubles were encountered, most likely due to low temperatures of the aquarium room, and quite a long time has been spent trouble shooting the machine. Some preliminary measurements have been conducted. Hopefully more data will be collected in the following months.

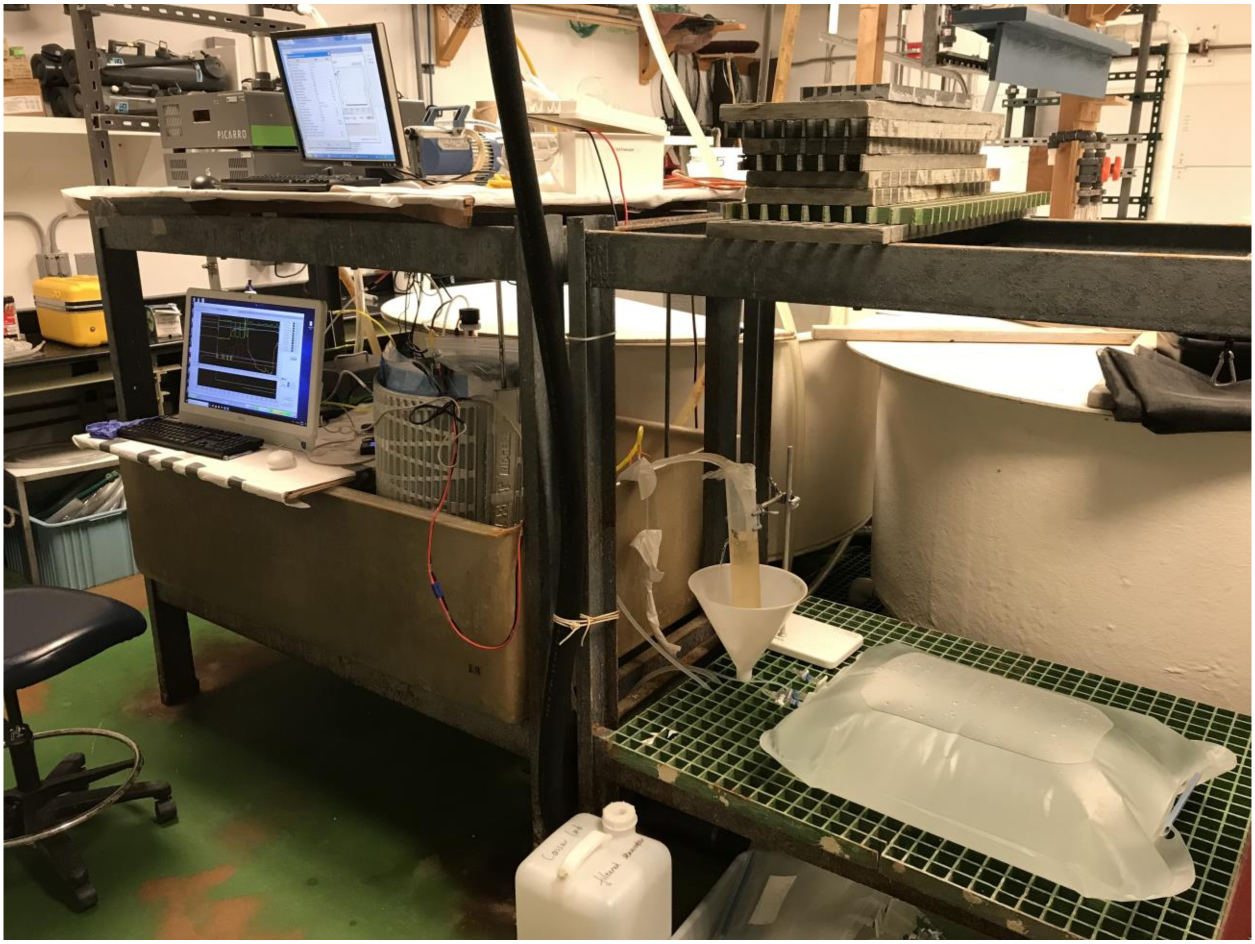

Fig. 13 – FARACAS setup in the aquarium room to measure nitrogen fixation in the seawater (Image credit: Shuai Gu).

$^{15}N_2$ incubation experiments were also conducted as a comparison to the FARACAS measurement. $^{15}N_2$ tracer was added into *in situ* seawater and incubated under ambient light and temperature conditions for 24 hours (Fig. 14), after which the particles would be filtered onto a GF/F filter. Nitrogen fixation rates can be calculated by measuring the ^{15}N signal in PON which comes from the added $^{15}N_2$ tracer. By combining these two different approaches of nitrogen fixation measurement, we would be able to double check the potential signals of nitrogen fixation.

Fig. 14 – $^{15}N_2$ incubation experiment in an outdoor cascade tank (Image credit: Shuai Gu).

G-094-P: RECONSTRUCTING LATE HOLOCENE ECOSYSTEM AND CLIMATE SHIFTS FROM PEAT RECORDS IN THE WESTERN ANTARCTIC PENINSULA

Dr. Zicheng Yu, Principal Investigator, Lehigh University

Personnel on Station: Dulcinea Groff, Zhengyu Xia, and Zicheng Yu

The current project is built on the observations, results, and findings from our fieldwork in 2013-2014 as part of our previous pilot project supported by the NSF Antarctic Earth Sciences Program. There are two field seasons for our project: (1) We have just completed our more extensive first season of data and sample collections in the southwest Anvers Island region near Palmer Station during January-February 2019; and (2) for the next 2019-2020 season onboard the ARSV *Laurence M. Gould*, we plan to expand our sampling regions from the northerly Cierva Point (Primavera Base) on the Danco Coast of mainland Antarctic Peninsula to the southerly Cape Tuxen on Graham Coast near Vernadsky Station.

We arrived at Palmer on 3 January 2019 aboard LMG19-01. We have had a very enjoyable and productive season at Palmer Station. Below we describe our rationale, observations, sampling activities, and ideas from this season at Palmer.

1. Importance of plant/peat microclimate—mediated by solar radiation and topography—in peatbank formation and accumulation

From the results of multiple cores on different aspects of Litchfield Island, we have learned that aspect plays a major role in peatbank initiation timing and accumulation rates. For example, the north-facing bank initiated much earlier at 2700 years ago than the west- and SW-facing banks at about 500 years ago, while the latter locations have much higher accumulation. Microclimate stations installed on north-facing and SW-facing slopes show significant difference in sunlight intensity, soil temperature, and soil moisture despite almost identical air temperature and relative humidity.

In January 2019, we set up two microclimate stations, one on a west-facing peatbank at Norsel Point, and another on a north-facing peatbank on Joubin Island #4 (Fig. 15). We hypothesize that the west-facing slope is probably the optimal aspect (“sweet spot”), among all aspects, for peat accumulation, as it receives less intense sunlight than the north-facing slope that often induces water stress. The Joubin Island microclimate station is on a young and shallow peatbank, which allows us to learn if the intense solar radiation and water limitation, especially later in summer, limit peatbank growth there. The new results will be compared with the data collected in 2014-2015 from Litchfield Island to test our ideas, after considering differences during these two periods.

Fig. 15 – Photos of two microclimate stations with 5 sensors for Photosynthetically Active Radiation (PAR), air temperature and relative humidity, wind directions and speed, soil temperature, and soil moisture. Top: Norsel Point (installed on 17 January 2019); Bottom: Joubin Island #4 (installed on 22 January 2019; Dulcinea Groff and Zhengyu Xia working on stabilizing the tripod). Image Credit: Yu group.

Also, we have collected detailed infrared thermal images using a FLIR infrared camera on a large NW-facing peatland (“Upper Green Valley”) on Litchfield Island. These include 12 plots on various decimeter-scale microtopographic features at different times of days on 11 and 12 January 2019. We have also collected measurements of moss cushions grown on two rock faces of different aspects (Fig. 16). A key finding is that moss surface can be much warmer—often reaching 30°C—than air temperature, which is rarely more than 5°C even in summer. Moss growth can benefit from high temperature as high as 15°C. Furthermore, the high plant temperature has implications for water (O and H) isotope enrichment and carbon assimilation that we often use as proxies of past climate and plant productivity. We have also collected more than 50 surface moss samples and moss tissue water samples for oxygen and carbon isotope analysis of moss cellulose, and oxygen and hydrogen isotope analysis of tissue water.

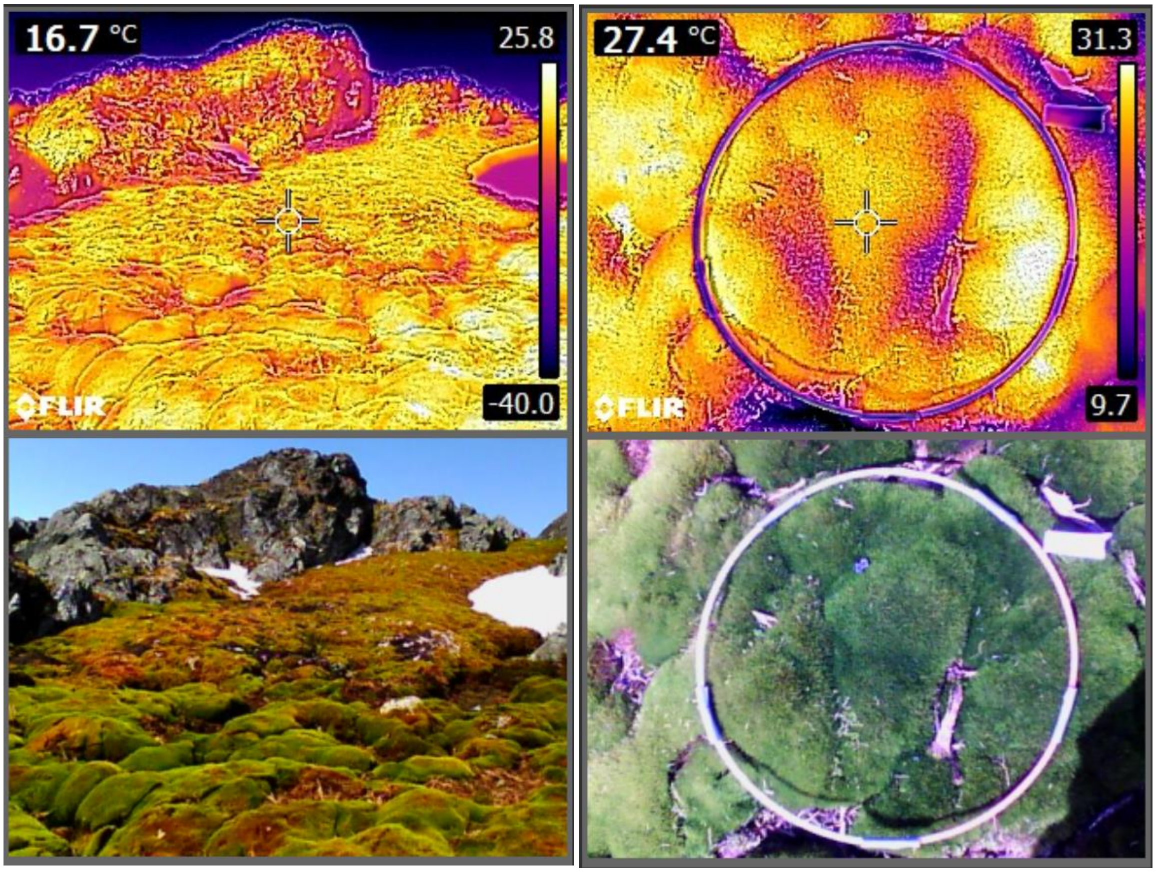

Fig. 16 – Examples of infrared thermal images from Upper Green Valley on Litchfield Island. Top images are enhanced infrared (temperature scale and range on the right in °C, and the reading on top-left corner shows the temperature at the center of the image), and bottom ones are RGB images, both taken by the same FLIR camera, simultaneously. Left images: peatbank view showing warm moss surfaces and cold sky and snow pack (taken at 14:00). Right images: peatbank surface (the ring is about 30 cm in diameter) showing temperature differences owing to cm-scale microtopographic aspects/slopes (taken at 17:00). Note that healthy mosses (*Chorisodontium*) reach a temperature of >30°C late in the afternoon, probably the time of day with the most intense sunlight for NW-facing slope (Image Credit: Yu group).

2. In search of novel ecosystems and new vascular plant species in Antarctica.

In the 2013-2014 season, we discovered that a *Deschampsia* (Antarctic hairgrass) peat bog occurred between about 2000 and 1000 years ago from core analysis of a peat core collected at Cape Rasmussen. We call this a novel type of ecosystem, as this ecosystem does not exist anywhere in Antarctica at present and the southernmost recorded location of *Deschampsia* peat bog at present is South Georgia. We also found a remnant of 2800-2100 year old moss-dominated peatland at Cape Rasmussen.

One of our goals in analyzing new peat cores collected this season and the next is to look for evidence of novel ecosystems that existed during the past warm climates. In addition to the only two vascular plants that now exist in Antarctica (*Deschampsia antarctica* and *Colobanthus quitensis*), we are looking for evidence of a third vascular plant to add to this list. In this season, we collected two long cores of 125-126 cm in length, the longest cores from the southwestern Anvers Island region, from a NW-facing (Fig. 17) and a west-facing slope. Also, we plan to carry out oxygen and carbon isotope analysis on moss cellulose to reconstruct paleoclimate over the last millennia, benefiting from our modern process study of surface moss and water sample analysis.

Fig. 17 – Peat coring of a large peatbank on Upper Green Valley on Litchfield Island. Left: Peat coring using a specially-built small-diameter permafrost corer to minimize damage to sensitive Antarctic peatbank ecosystems by Dulcinea Groff and Zhengyu Xia; Middle: Surface monolith collected using a bread knife; and Right: Frozen section of the core 100 cm below the surface (Image Credit: Yu group).

These cores also allow us to explore long-term peatbanks – animal (fur seals, penguins) interactions along the coast of the western Antarctic Peninsula over the last millennia—this is a potential new research direction in collaboration with Palmer LTER researchers.

Furthermore, we think that we might have discovered possible waterlogged moss-dominated peatlands on Hermit (Fig. 18) and Cormorant Islands near Palmer Station. These wetlands—likely dominated by a wet brown moss *Warnstorfia*—accumulate up to 50 cm deep peat in rock depressions facing mostly west. We will need to carry out laboratory dating and macrofossil analysis to confirm if the peats accumulated over the last several decades, likely as a response to recent and ongoing regional warming, or a relic peatland accumulated a couple thousand years ago when climate was warmer as we found at Cape Rasmussen near Vernadsky Station.

Fig. 18 – Possible moss-dominated peatlands on Hermit Island near Palmer Station. Left: The west end of the island showing rock depressions/basins with peat accumulation; Right: Core photo of a 40-cm long peat core (Image Credit: Yu group).

3. Dating re-exposed mosses/peat from retreating ice to reconstruct glacier advance history. In the 2013-2014 season, we collected and dated some dead moss samples from Bonaparte Point that show the potential to use these dates ("kill ages") to reconstruct glacier advance history. The limited number of dead moss dates show that the ice margin on Bonaparte Point advanced at a speed of about a half meter per year during the cold "Little Ice Age". We know from satellite images that Marr Pediment Ice has retreated rapidly over the last several decades, and the ice margin at Gamage Point (Palmer backyard) has retreated much faster than on Bonaparte Point. This recent glacier retreat exposed ice-entombed dead mosses that can be radiocarbon-dated to obtain their "kill ages". We had no dead moss dates from Gamage Point from the previous season, but in this season we have collected more than 30 dead-moss samples, in addition to >30 new samples from Bonaparte Point (Fig. 19). We are hopeful that we will soon develop a glacier advance history of the backyard at Palmer Station by dating these samples. The results will allow us to compare and understand the relationship between glacier advance and retreat speeds, considering very different retreat speed at Gamage Point (10 m per year) and Bonaparte Point (<5 m per year).

Fig. 19 – Google Earth image (date April 2017) showing the locations of existing dates (yellow) collected in the 2013-2014 season and new samples (blue) collected in the 2018-2019 season on Bonaparte Point and Gamage Point, along with glacier retreat history in recent decades (Image credit: Yu group and DigitalGlobe imagery © 2018).

4. Emerging new ideas and projects.

We have discussed the possibility of carrying out a detailed survey of peatbank distributions using UAS (Unoccupied Aircraft Systems), such as on Litchfield Island. Together with topographic measurements by UAS, especially cm-scale digital elevation mode (DEM), we will be able to analyze and understand topographic (elevations, aspects, and slopes) controls of peatbank distributions—with a goal to identify the preferred or optimal landscape positions for peatbanks. Along with LTER scientists (especially seal and bird groups) working around Palmer Station, we may expand the effort to compare the peatbank distributions with fur seal activities and penguin colonies to understand their interactions on landscapes. We will start this effort next season, hopefully in collaboration with other teams who have common or complementary interests.

We are also looking into other aspects of plant-animal interactions. For example, how plant distributions and growth, in particular mosses and peatbanks, are affected by nutrient inputs from bird guanos. We observe that Litchfield Island—especially its west-facing slopes—has the most luxuriant plant cover and peatbank growth in the region. We hypothesize that Litchfield Island receives “optimal” air-borne nutrient inputs because of its proximity to major penguin colonies on Torgersen and Humble Islands, especially on slopes further away from these colonies. We have initiated a project this season to characterize the nutrient deposition gradients among islands, from locations near major penguin colonies on Torgersen and Humble Islands to as far as Gossler Islands. We have collected *Usnea* lichens and other plant samples at locations of various distances and presumably different influences from penguin guano sources. These results potentially allow us to answer questions such as: is there an “optimal” nutrient level or distance from guano sources for moss growth and peat accumulation? We have observed that there are abundant, large, and healthy *Dechampsia* on Torgersen Island that has a large penguin population, but there is almost no *Usnea* lichens and mosses there. Does this high nutrient level on Torgersen negatively impact the growth of mosses and lichens, but still benefit vascular plants like *Deschampsia*?

Another possible project is to look into long-term interactions of moss peatbanks and fur seal/penguins using peat cores or other soil deposits. Developing a geochemical or molecular fingerprint of these animals would allow us to date their first appearance in this region and to understand their ecological interactions on the landscape.

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PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT

January 2019
Marissa Goerke

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

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

The ionosphere-thermosphere-magnetosphere (ITM) region of Earth's atmosphere, which is part of the larger geospace environment, is the portal through which the solar wind can enter and impact our planetary system. Though space weather research over the past decades has greatly increased our understanding of a wide variety of phenomena associated with ITM physics, the sum of these individual processes occurring in the geospace environment does not replicate the rich diversity and scope of this complex region. Thus, a more holistic approach to ITM research is necessary, one that integrates clustered instrumentation at multiple locations to simultaneously look at the interactions within the entire system. Using coordinated and collaborative instrumentation currently installed in Antarctica, researchers will study interrelated ITM phenomena observed at high latitudes. The goal of this research effort is a better understanding of the energy transfer and modulation of the geospace system.

The system operated normally throughout the month.

A-119-P: CONTINENTAL-SCALE STUDIES OF MESOSPHERIC DYNAMICS USING THE ANTARCTIC GRAVITY WAVE INSTRUMENT NETWORK (ANGWIN)
Dr. Michael Taylor, Principal Investigator, Utah State University

The Antarctic Gravity Wave Imaging Network (ANGWIN) is a cooperative effort of six international Antarctic programs to collect continent-wide gravity wave measurements. This network capitalizes on existing optical and radar measurement capabilities at McMurdo, Palmer, South Pole, and six other research stations: Halley (UK), Syowa (Japan), Davis (Australia), Rothera (UK), and Ferraz (Brazil). Infrared (IR) all-sky mesospheric OH (hydroxyl) imagers are installed at Davis, McMurdo, and Halley stations. The network quantifies the properties, variability, and momentum fluxes of short-period (less than one hour) mesospheric gravity waves and their dominant sources and effects over the Antarctic continent. An all-sky near-IR imager is also installed at Palmer Station to augment the existing instrumentation and create a capability for studying gravity wave properties at each site.

The system is shut down for the summer season.

A-373-P: TROPOSPHERE-IONOSPHERE COUPLING VIA ATMOSPHERIC GRAVITY WAVES
Dr. Vadym Paznukhov, Principal Investigator, Boston College

The goal of this project is to enhance the comprehensive research understanding of troposphere-ionosphere coupling via Atmospheric Gravity Waves (AGWs) in the Antarctic region. Both experimental and modeling efforts will be used on the Antarctic Peninsula to investigate the efficiency and main characteristics of such coupling and will address several questions remaining in the current understanding of this coupling process.

The system operated well throughout the month. The system will be removed and retrograded in the upcoming months.

G-090-P: GLOBAL SEISMOGRAPH NETWORK (GSN) SITE AT PALMER STATION
Mr. Kent Anderson, Principal Investigator, Incorporated Research Institutions for Seismology (IRIS)

Station PMSA is one of more than 150+ sites in the GSN, monitoring seismic waves produced by events worldwide. Real-time telemetry data is sent to the U.S. Geological Survey (USGS). The Research Associate operates and maintains on-site equipment for the project.

The system operated normally throughout the month.

O-264-P: A STUDY OF ATMOSPHERIC OXYGEN VARIABILITY IN RELATION TO ANNUAL DECADAL VARIATIONS IN TERRESTRIAL AND MARINE ECOSYSTEMS
Dr. Ralph Keeling, Principal Investigator, Scripps Institution of Oceanography

The goal of this project is to resolve seasonal and interannual 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 Research Associate collects samples fortnightly from Terra Lab.

Air samples were taken twice this month.

O-264-P: COLLECTION OF ATMOSPHERIC AIR FOR THE NOAA/GMD WORLDWIDE FLASK SAMPLING NETWORK
Mr. Don Neff and Dr. Steve Montzka, Principal Investigators, National Oceanic and Atmospheric Administration / Global Monitoring Division

The NOAA ESRL Carbon Cycle Greenhouse Gases (CCGG) group makes ongoing discrete measurements to document the spatial and temporal distributions of carbon-cycle gases and provide essential constraints to our understanding of the global carbon cycle. The Halocarbons and other Atmospheric Trace Species (HATS) group quantifies the distributions and magnitudes of the sources and sinks for atmospheric nitrous oxide (N2O) and halogen containing compounds. The Research Associate collects weekly air samples for the CCGG group and fortnightly samples for the HATS group.

CCGG samples were taken once a week during favorable winds and HATS Air samples were taken every other week.

O-264-P: ULTRAVIOLET (UV) SPECTRAL IRRADIANCE MONITORING NETWORK
Dr. James Butler, Principal Investigator, National Oceanic and Atmospheric Administration / Global Monitoring Division

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

The system operated normally throughout the month. Bi-weekly absolute scans were completed as necessary.

R-938-P: TERASCAN SATELLITE IMAGING SYSTEM

The TeraScan system collects, processes, and archives DMSP and NOAA satellite telemetry, capturing approximately 25-30 passes per day. 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 system operated normally throughout the month. System was shut down briefly for the Terra Lab UPS install.

T-295-P: GPS CONTINUOUSLY OPERATING REFERENCE STATION.
Mr. Joe Pettit, Principal Investigator, UNAVCO

Continuous 15-second epoch interval GPS data files are collected at station PALM, compressed, and transmitted to the NASA-JPL in Pasadena, CA. The Research Associate operates and maintains on-site equipment for the project.

The system operated normally throughout the month.

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

The IMS Radionuclide Aerosol Sampler and Analyzer (RASA) is part of the CTBTO verification regime. 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 has operated normally throughout the month.

OCEANOGRAPHY
Daily observations of sea ice extent and growth stage are also recorded, along with continuous tidal height, ocean temperature, and conductivity at Palmer's pier.

Observations of sea ice around station were made daily and the tide gauge has operated normally throughout the month.

METEOROLOGY
The Research Associate acts as chief weather observer, and compiles and distributes meteorological data. Weather data collected using the automated electronic system is archived locally and forwarded once per month to the University of Wisconsin for archiving and further distribution. Synoptic reports are automatically generated every three hours by the Palmer Meteorological Observing System and emailed to the National Weather Service for entry into the Global Telecommunications System.

The local weather station (PAWS) is working well. The Gosslers AWS was installed on 8 January 2019. Observations are archived on the AMRC website: ftp://amrc.ssec.wisc.edu/pub/palmer/.