PALMER STATION MONTHLY SCIENCE REPORT

FEBRUARY 2019

The ASC Rigger team (Levi Littrell and Andrew White) replace the Backyard weather station tower with assistance from Communications Technician PJ Charpentier (not pictured), Telecommunications Supervisor Michael Pfalmer, and Research Associate Marissa Goerke.
Image Credit: PJ Charpentier

NEWS FROM THE LAB

Randy Jones, Summer Laboratory Supervisor

The start of the month brought the return of the ARSV *Laurence M. Gould* following the successful month-long LTER cruise along the Antarctic Peninsula. Several grantees arrived and departed during this northbound port call. Science efforts continued across the boating region, with intensive collaborative efforts focused on Wylie Bay, Biscoe Bay, Bismarck Strait, and the Palmer Canyon region, and on the island groups – Gossler, Joubin, Waumermans, and near Station Islands.

Overall, the weather conditions have been relatively mild, with a slow, but noticeable transition to colder temperatures. The majority of the month was relatively dry, and rain precipitation was minimal. Snow cover on the islands is now minimal, but still persistent in places. Brash ice from glacial calving activity filled Hero Inlet and Arthur Harbor at times, and icebergs were prevalent in the region. Seawater temperatures have begun dropping, yet there has been a series of phytoplankton blooms and declines that have alternatively clouded or cleared the water. Wildlife has been abundant with an increase in fur seals and leopard seals in the region.

FEBRUARY 2019 WEATHER
Marissa Goerke, Research Associate

Temperature
Average: 0.8°C / 33.4°F
Maximum: 7.3°C / 45.1°F on 6 Feb 14:33
Minimum: -3.4°C / 25.9°F on 28 Feb 08:00
Air Pressure
Average: 986.6 mb
Maximum: 1006.1 mb on 28 Feb 21:46
Minimum: 960 mb on 14 Feb 01:24
Wind
Average: 7.3 knots / 8.4 mph
Peak (5 Sec Gust): 42 knots / 48 mph on 17 Feb 12:45 from N (5 deg)
Prevailing Direction for Month: SSW
Surface
Total Rainfall: 29.2 mm / 1.15 in
Total Snowfall: 1.0 cm / 0.4 in
Greatest Depth at Snow Stake: 25.2 cm / 9.8 in
WMO Sea Ice Observation: No sea ice in sight with 1-5 ice bergs and bergy bits.
Average Sea Surface Temperature: 1.05°C / 33.90°F

Temperatures peaked at 7.3°C on 6 February and reached a low of -3.4°C on 28 February. The wind peaked at 48 mph on 17 February and averaged 8.4 mph for the month. The prevailing wind direction for the month was from the south-south-west (Fig.1). We accumulated 1.0 cm of snow and had 1.1 inches of rain fall. The snow field measured by the snows takes has still not melted. There has been brash ice in the area occasionally as well as several large icebergs in the area.

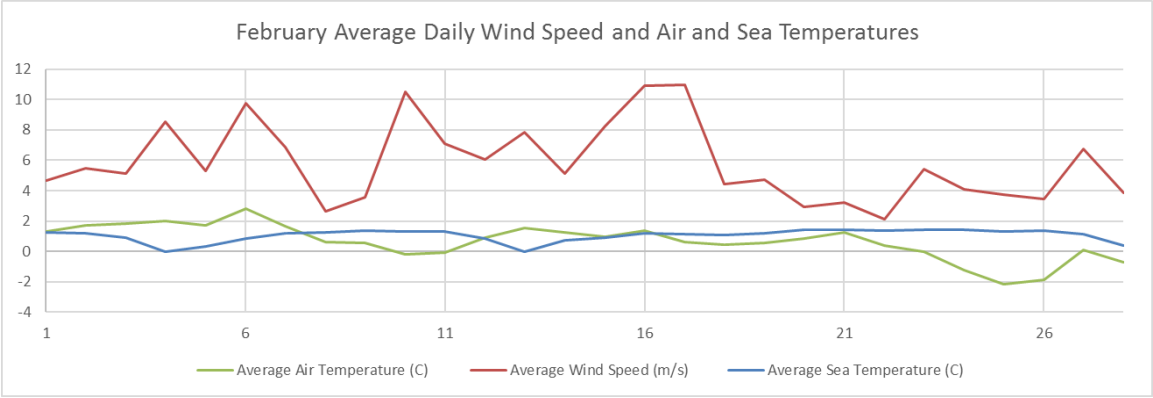

Fig. 1 – Average daily wind speed (red line; m s^{-1}), average daily air temperature (green line; C), and average daily seawater temperature (blue line; C) for the month of February 2019. Image Credit: Marissa Goerke.

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

Carbon Fluxes I – Field Warming Experiment

For our carbon warming experiment, we are determining if the warming treatments has affected the physiology of the vegetation. In February we took weekly carbon flux measurements in all the plots (Fig. 2, left photo). One of those weekly measurements included light-response curves: using the sun as a natural light source, we used layers of shade cloth to generate dimmer and dimmer conditions and recorded net ecosystem carbon exchange. The light-response curves provide information on ecosystem respiration (completely dark), the light compensation point (LCP; i.e., above what light level net photosynthesis starts), and the maximum photosynthetic rates at saturating light level (A_{sat}).

Fig. 2 – Kelly McMillen and Alicia Purcell measuring net ecosystem carbon exchange (NEE; left photo). It is apparent that we are measuring communities of different vegetation types within the collar: moss and lichen (right photo).

We are measuring carbon fluxes of communities of vegetation (Fig. 2, right photo), so in mid-February we took individual plant samples of different species that occur in our plots. We sampled mostly from Amsler Island and Bonaparte Point to minimize sample collections at Litchfield Island. We are using these samples to get a better understanding of the physiological capacities of the different species and relate these to the field measurements (see next section regarding our lab incubation). For example, if a plot has high net ecosystem carbon exchange and is dominated by *Polytrichum strictum* (the bright green species in the above right photo), then we can state that those high fluxes are attributed to the abundance of that species.

Carbon Fluxes II – Lab incubation experiment

We are conducting a lab incubation experiment at 0° and 20°C using various moss species. A lab incubation will help us better understand the physiology of the individual moss species that

comprise the plant communities in our plots. We collected small moss plugs side-by-side from different mosses, so that we used genetically identical samples whereby one set was incubated at 0 and the other (genetically identical set) at 20°C. After 1.5 weeks of incubation at the two temperatures there were striking differences in moss morphology (Fig. 3, right photo).

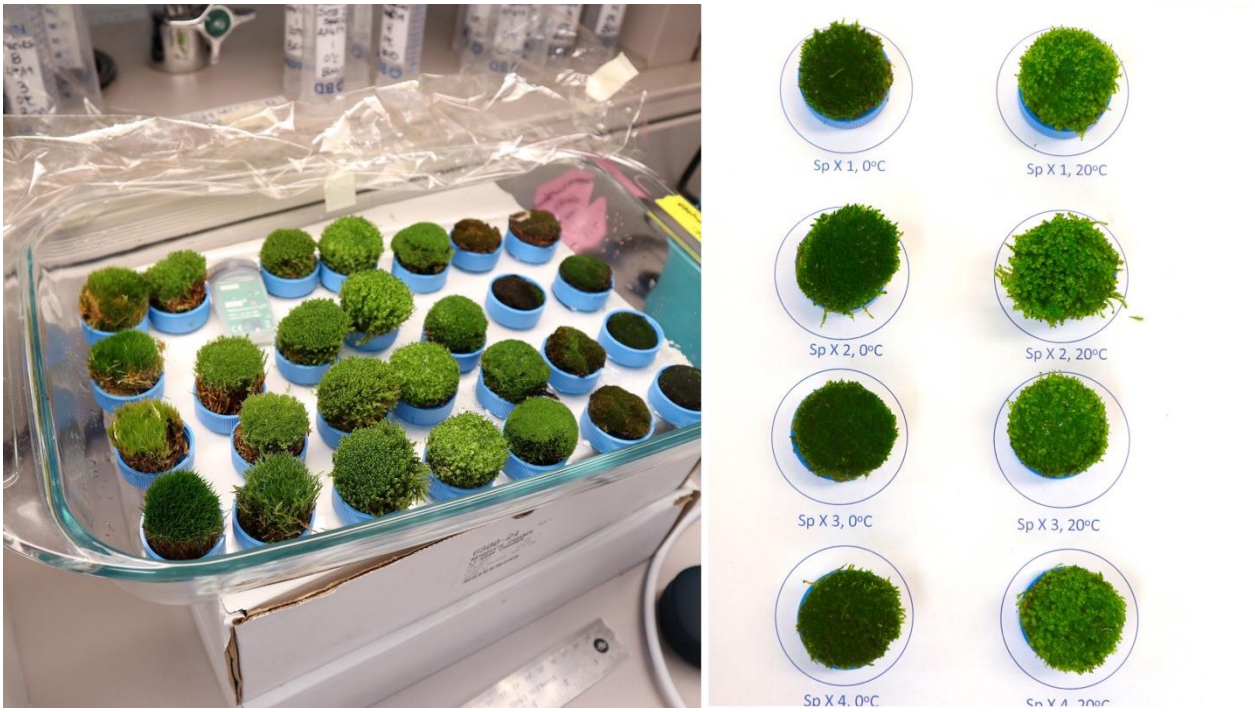

Fig. 3 – A 1.5-week warming experiment was conducted to incubate moss plugs at two different temperatures (0° and 20°C; 20°C room temperature condition shown in left photo). At the start of the incubation, the moss plugs were visually the same (as each pair was harvested side-by-side and are thus genetically the same; plugs are the diameter of a 50ml falcon tube and fit in the bryophyte chamber). There were strong temperature effects observed between the two temperatures (right photo).

We measured light response curves of the moss. We hypothesize that moss acclimate to their ambient growing environment such that photosynthetic rates - and hence, curve parameters (e.g., dark respiration rates, LCP, and A_{sat},) are similar between the moss growing at 0°C and at 20°C. We also took morphology measurements to determine how much the moss grew during the incubation period (Fig. 4).

Other Efforts

- We exchanged Plant Root Simulator (PRS®) probes that had been in the field for four weeks with fresh PRS® probes on February 19-20.
- We collected soil samples that we are sending back to our home lab for assessing growth rates of bacteria and fungi using radioactive tracers.
- We took photos of the vegetation inside each plot to assess the abundance of different plant species inside each plot.

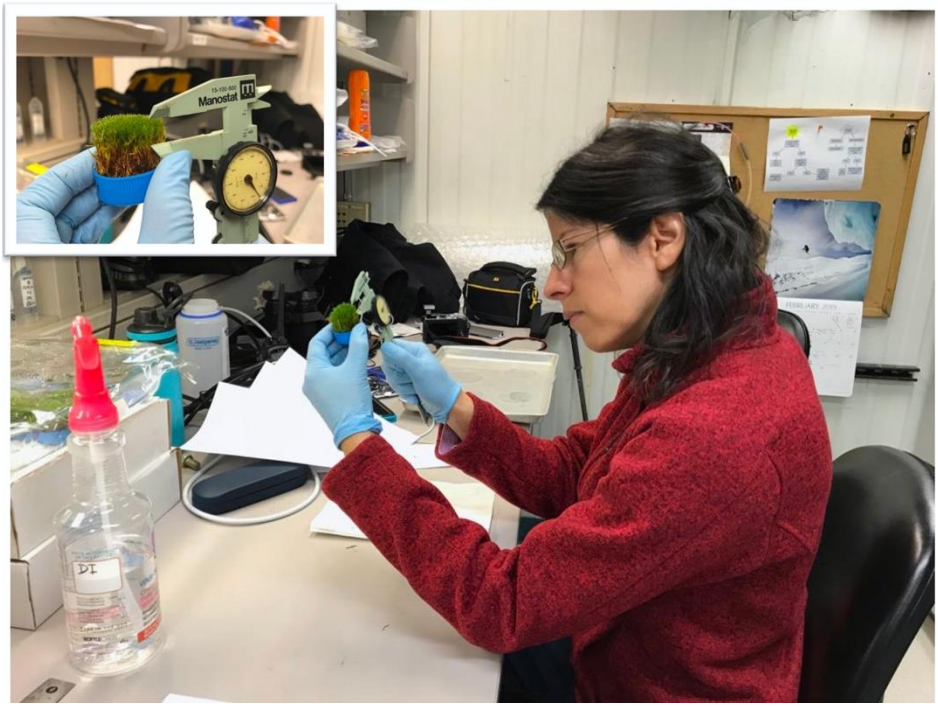

Fig. 4 – Measuring leaf area of moss (height, diameter, and width of the green area). This particular species is *Polytrichum strictum*.

Outreach Efforts

- We skyped with 4th graders from Northridge Elementary in Lubbock, TX. Two 4th grade groups participated from the same class-room during the Skype session. It was a great session, because the students were eager to ask questions (and they asked very good ones, specific to my research area – I was very impressed) – and they delighted in seeing the iceberg outside the window (Skype outside was not possible because of the bad weather). This was our second Skype session (our first one was in January with the Sinagua Middle School in Flagstaff).
- My daily blog now has >1000 users! The users are from 29 countries.
- On several occasions, I have interacted with visitors from tour ships. It is a pleasure to see how the visitors are so engaged with the science conducted at Palmer Station. I advertise my blog, so that during their short stay they can read more about the science here.

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, Donna Patterson-Fraser, Darren Roberts, and Megan Roberts

On 6 February, the ARSV *Laurence M. Gould* made a brief return to Palmer Station with C-013-P/L team members Megan Roberts and Anne Schaffer at the conclusion of a successful LTER

cruise. In addition to ship based surveys and a week of intense data collection on Avian Island, the C-013-L cruise team also succeeded in conducting shore based penguin surveys on Hugo Island, and Armstrong Reef. The ship based team was also able to recover penguin tags from the Joubin Islands when weather did not allow the Station team to transit that distance. On 8 February, the *Gould* departed Palmer Station with C-013-P/L team members Bill Fraser, Megan Cimino, Alex Dutcher, and Anne Schaffer. Donna Patterson-Fraser arrived to station on LMG 19-02.

Back in the Palmer Station area, Adélie penguin studies concluded this month with beach counts and measurements of Adélie fledglings. Adélie penguin foraging ecology studies were also concluded in February with the completion of our radio transmitter study on Humble Island. Satellite tagging of Adélie penguins concluded in February. Gentoo penguin satellite tag deployments, fledgling measurements, and diet studies on Biscoe Island and in the Joubin Islands were conducted in February and will continue into March. Satellite tags were also deployed on Chinstrap penguins at the Joubins.

A south polar skua chick at Shortcut Island. *Image Credit: Fraser group*

Skua work continued through February with monitoring and banding of brown skua chicks on local islands as well as on Dream and Biscoe Islands. South polar skua reproductive monitoring on Shortcut Island continued throughout February as did the monitoring of the blue-eyed shag colony on Cormorant Island. Kelp Gull surveys and chick counts were also completed for local islands. Growth measurements of giant petrel chicks on Humble Island continued every other day during February and will continue until chick fledging in April.

As always, ASC provided outstanding science support this month. Special thanks to all the ASC and grantee field volunteers that assisted with Adélie fledgling measurements. Lab Supervisor Randy Jones and Instrument Technician Carolyn Lipke deserve special thanks for going above and beyond for our group. Resident Marine Technician Dave Moore was a huge asset to Station and his presence in the Boathouse will be missed. Chefs Francis Sheil, and Derrick Watson have been amazing this season and we thank them for keeping our team running throughout the season.

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: Hailey Conrad, Schuyler Nardelli, and Marie Zahn

This month we said goodbye to Marie Zahn and welcomed Hailey Conrad. Hailey is an undergraduate student at Rutgers University, majoring in biological oceanography and ecology. We are excited to have her on board for the rest of the season!

The beginning of February started amidst the mid-summer phytoplankton bloom, with 50m-integrated chlorophyll fluorescence values over 300 mg m^{-2} (Fig 5). Primary production rates also hit season highs for all depths measured (Fig. 6). This early February bloom was associated

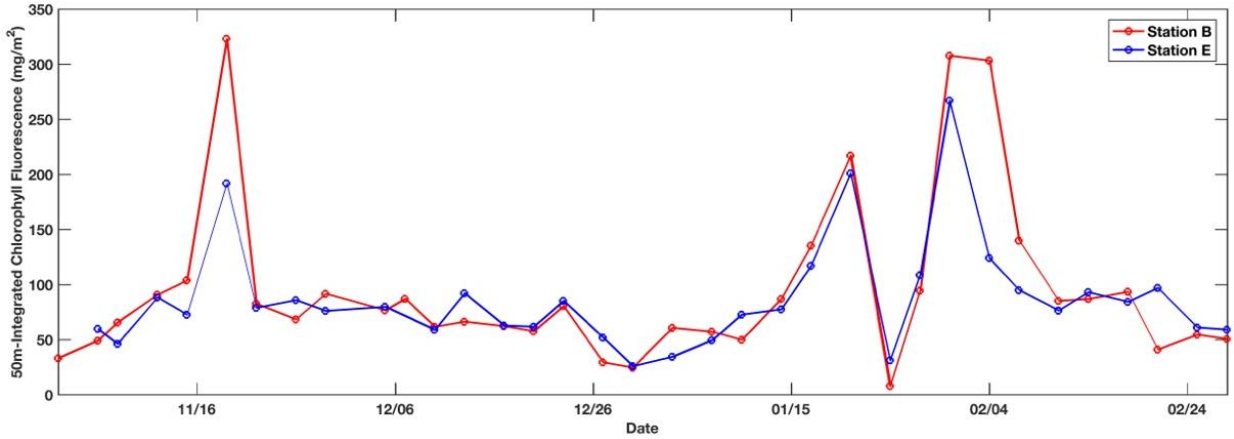

Fig. 5 – 50-m integrated chlorophyll fluorescence at Stations B (red line) and E (blue line) for November 2018 to February 2019.

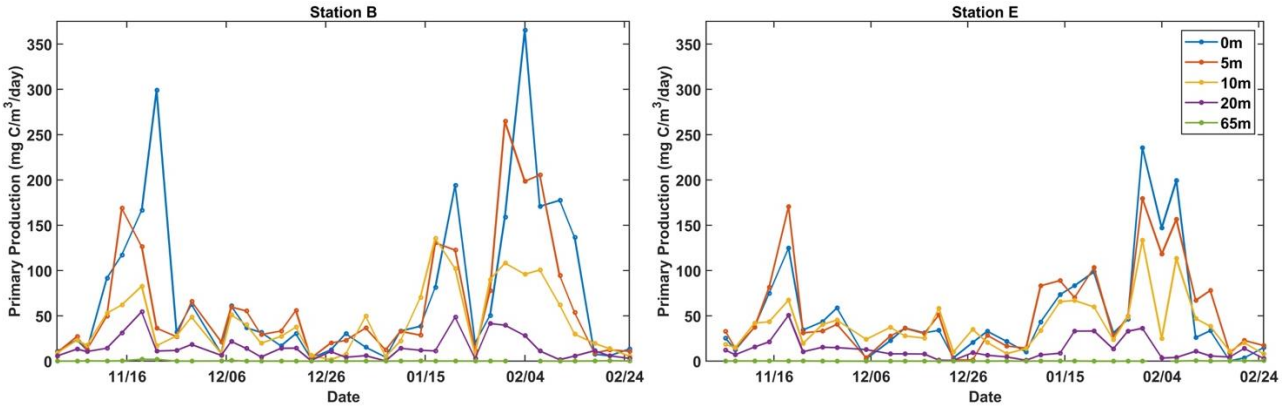

Fig. 6 – Primary production rates (mg m^{-3} day^{-1}) for all depths measured at Stations B (left) and E (right) for November 2018 to February 2019.

with a shallower mixed layer depth (Fig. 7). As February progressed, chlorophyll and primary production progressively dropped, in combination with an increase in wind speed and a resulting deterioration of the summer surface mixed layer.

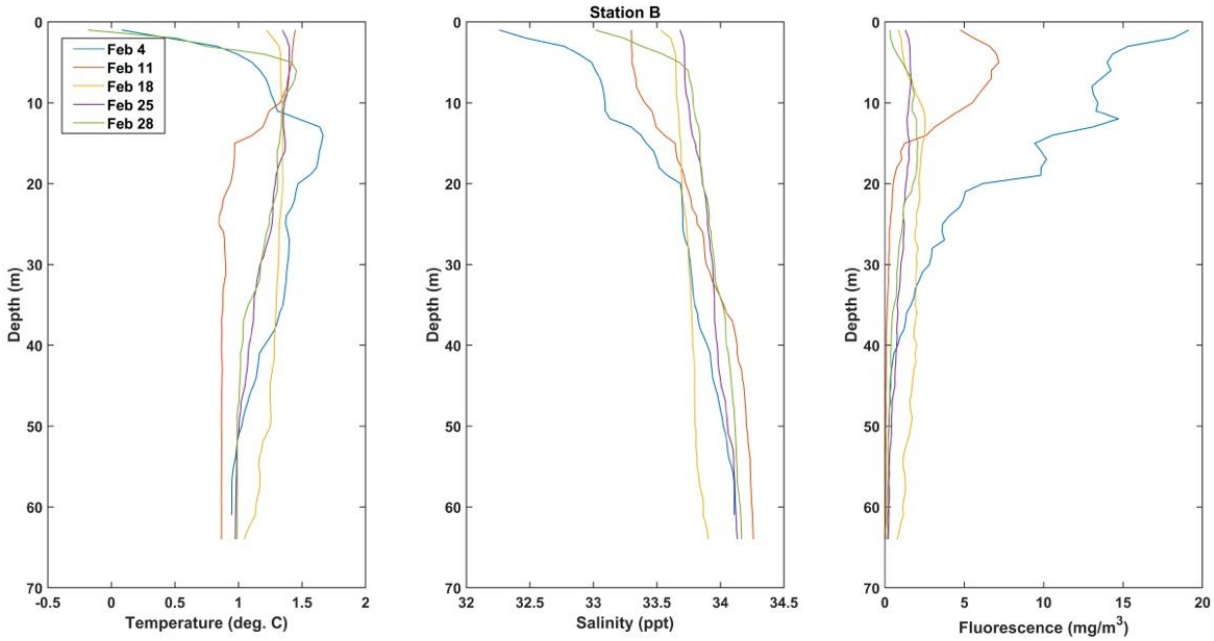

Fig. 7 – Temperature (left; deg. C), salinity (middle; ppt), and fluorescence (right; mg m^{-3}) profiles for Station B over the course of February 2019.

Collaborative work with the C-013-P (Fraser), C-020-P (Steinberg), and C-024-P (Friedlander) labs continued this month. In February, we completed eight acoustic surveys mapping krill distribution – four over the Palmer Canyon targeting the center of local Adélie penguin foraging, and four out by Biscoe Point and the Wauwermans Islands targeting the center of local gentoo penguin foraging (Fig. 8). This brings our acoustic survey total to 18 for the season. Early February transects also coincided with gentoo penguin and humpback whale tagging. We are very excited to piece together the physical, acoustics, and tagging data later this spring to investigate the dynamics that set up foraging hot spots around Palmer Station!

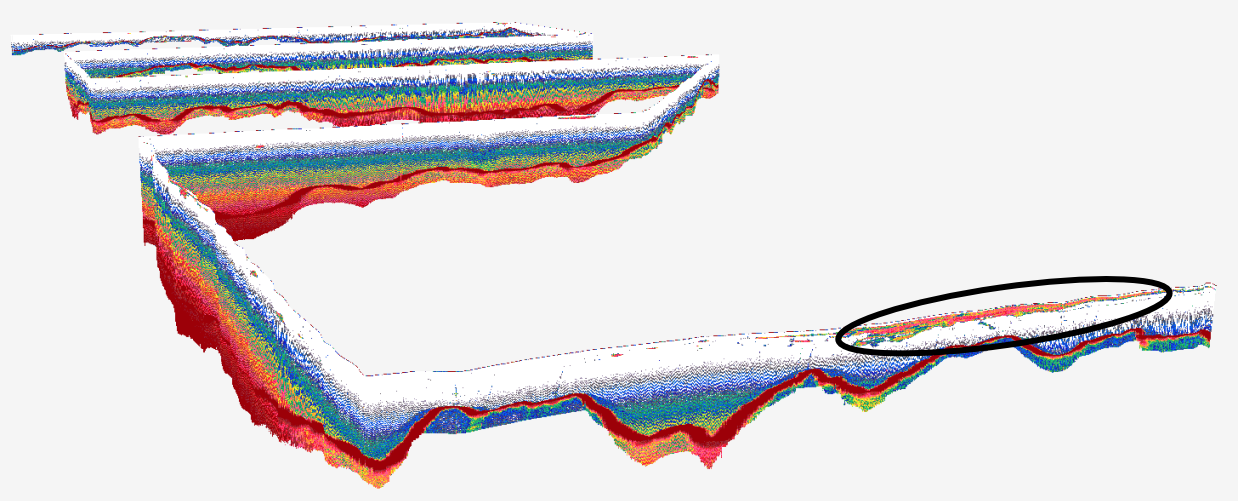

Fig. 8 – 3D imagery of the Gentoo acoustic survey, from 15 January 2019. A large surface krill swarm is indicated by the black circle.

Thank you to ASC for all their hard work supporting our science! In particular, thank you to the marine technicians who help us in the field daily, and to Instrument Technician Carolyn Lipke and Laboratory Supervisor Randy Jones for their help in the labs.

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

The zooplankton team conducted 82 net tows and spent 16 sampling days on the water in February. We have now conducted 343 net tows this summer, already surpassing last year's total of 315 tows.

We sampled the Palmer LTER time series Stations B and E eight times last month. A notable decline in Antarctic krill (*Euphausia superba*) abundance was evident in February. *Thysanoessa macrura*, a smaller krill species, was abundant throughout the month and dominated zooplankton community biomass (Fig. 9). High densities of *T. macrura* were also observed throughout the Antarctic Peninsula region during the recent LTER cruise. In 2017-2018, *T. macrura* was rarely present near Palmer Station. Active acoustic surveys have revealed that *T. macrura* is distributed in thin horizontal layers compared to the dense schools typical of *E. superba*.

Fig. 9 – Zooplankton sample with both common krill species. *Euphausia superba* is larger, and *Thysanoessa macrura* is smaller with bulging eyes.

February brought a distinct shift in the copepod community. For the first time this summer, omnivorous calanoid copepods (*Calanus propinquus*) were more abundant than herbivorous species (*Calanoides acutus* and *Rhincalanus gigas).* Small (200-500 micron), omnivorous copepods (*Oithona* spp.) also appeared to increase in abundance during February. A similar shift in the copepod assemblage was observed in 2017-2018, but the shift occurred later this summer. A prolonged phytoplankton bloom this January is a likely driver for the delayed assemblage switch.

Small-scale spatial differences in the zooplankton community are becoming evident. Weekly offshore sampling trips to the northern and southern flanks of the Palmer Canyon allow comparisons with the nearshore Station B and canyon edge Station E (Fig. 10). Zooplankton biomass and abundance appear to be consistently highest inshore at Station B. The northern flank of the Palmer Deep has repeatedly shown higher phytoplankton and zooplankton biomass compared to the southern flank.

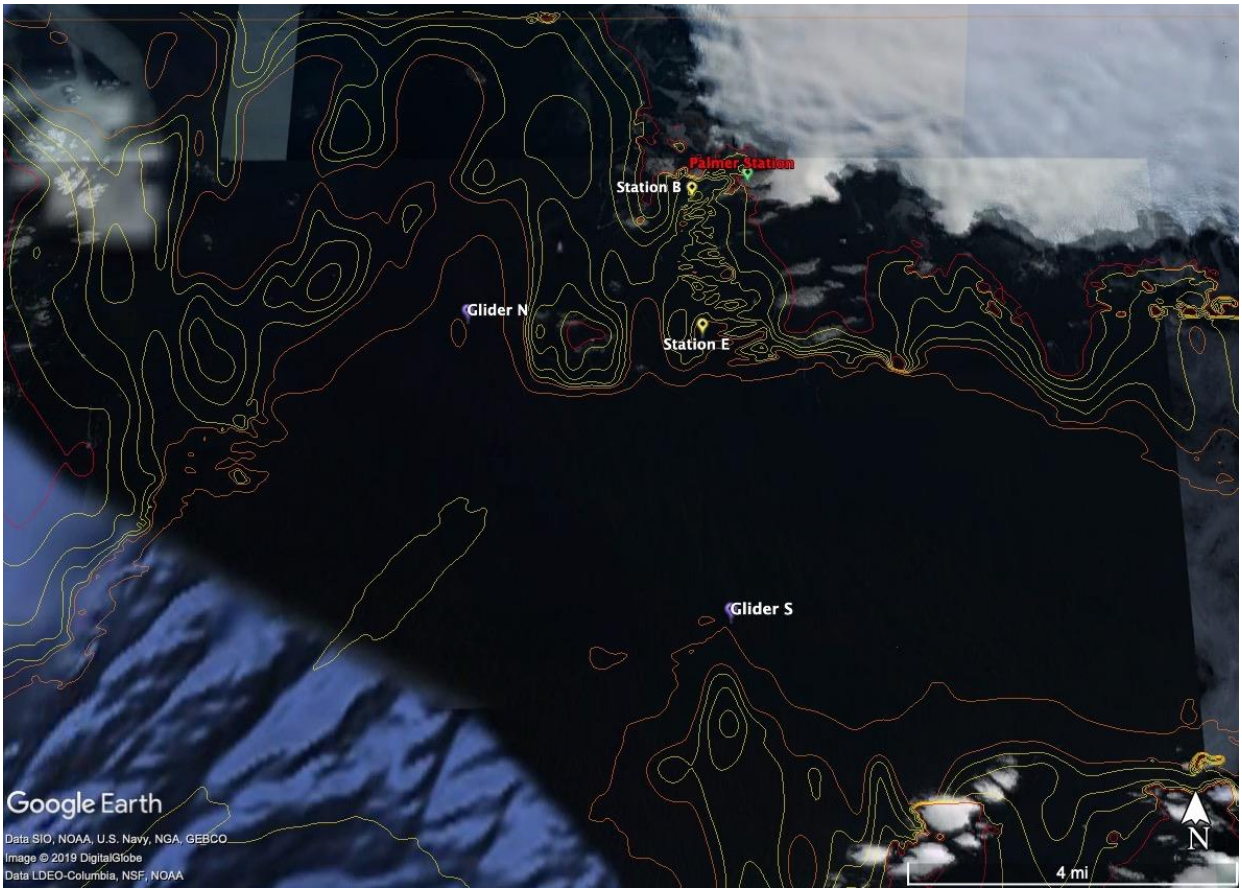

Fig. 10 – Map indicating four plankton sampling stations. Stations B and E have been occupied by LTER researchers since 1993. The Glider North and Glider South stations in the Palmer Canyon were established this year in conjunction with an Autonomous Underwater Vehicle deployment.

We completed weekly surveys in both Adélie and gentoo penguin foraging regions. Predator, krill, and phytoplankton abundance all declined relative to January. Strong winds drove deep mixing, which likely quenched the January phytoplankton bloom. Antarctic krill likely responded to a change in their local food availability as did transient krill predators.

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, Ross Nichols, and Logan Pallin

Whale Survey, Photo-ID, Biopsy Efforts

February was a successful and fruitful month for the C-024-P group. Logan Pallin departed station at the end of LMG19-01 and Ross Nichols joined the Palmer Station whale team. 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 from echosounders) and the foraging behavior of local penguins. In addition to the field team at Palmer Station, multiple team members and collaborators are deployed on the ARSV *Laurence M. Gould* to collect similar information on the foraging behavior and ecology of the Antarctic minke whale and humpback whales.

We have continued to conduct daily 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, biopsy sampling, and UAV photogrammetry are done opportunistically whenever whales are encountered. Starting on 2 February and continuing through the 9 February, a large aggregation of whales was seen in the local Palmer area, and the extended boating areas. This aggregation mirrored much of what we observed in between 17-24 January during a large phytoplankton bloom. Logan, Ross and Greg have spent a total of ~226 hours on the water surveying for whales. In the 51 days of the field season so far, they have observed 522 humpback whales, collecting 105 biopsy samples and nearly 240 photo-ID photos of individual whales. Ross and Greg have also observed a total of 63 calves, which have seen increased numbers in February (Table 1, Figure 11). Humpback whale mother-calf pairs were sighted 60% more often in February, a trend our group has observed the previous 3 years. We have only observed one other cetacean species, the Antarctic minke whale. We have observed six minke whales over the last two months and collected one tissue sample. For a comprehensive look on the spatial whale abundance over the course of the whalers' season at Palmer Station, see Figure 12.

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.

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

Total Effort Time	226:15:00

	Total Whales Sighted	Total Calves	Total Adults	Full Photo ID
Humpback	518	63	455	240
Minke	4	0	4	
Orca	0	0	0	
Fin Whale	0	0	0	
Unknown	0	0	0	
Totals	**522**	**63**	**459**	**240**

Biopsies Palmer	Total Samples
Humpback	105
Minke	1

Biopsies All Platforms	Total Samples
Humpback (w/ tagging)	162
Humpback (w/o tagging)	148
Minke	1

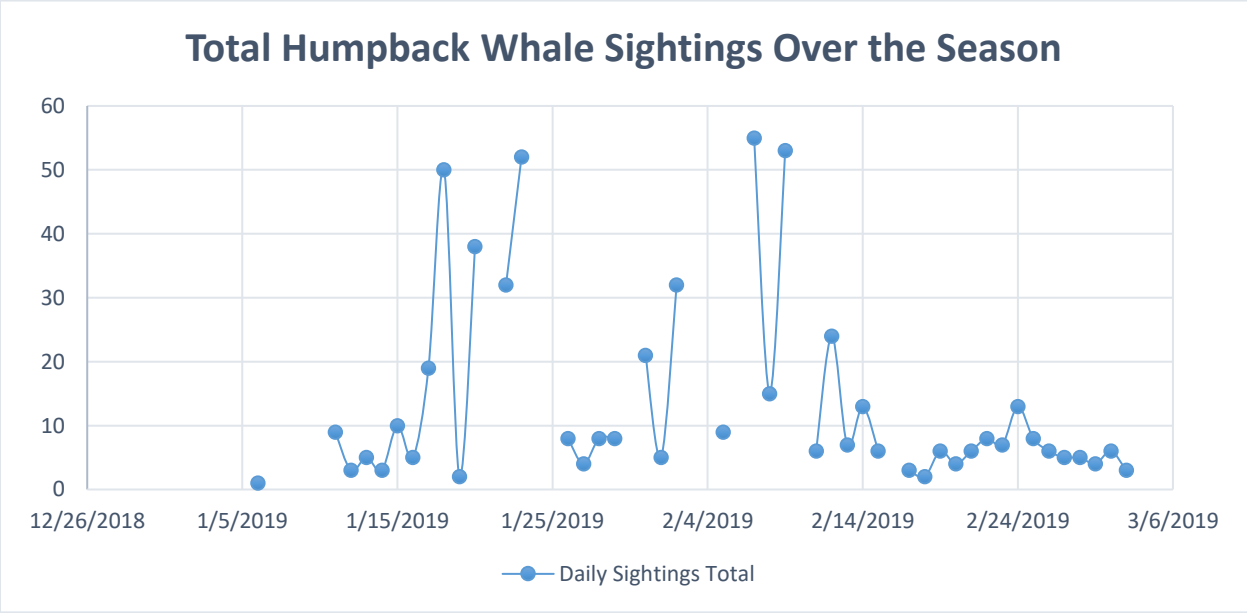

Fig. 11 – Total whale sightings recorded by the C-024-P (Friedlaender) team at Palmer Station from 5 Jan 2019 to 3 Mar 2019 (blue points). Two large spikes were seen this year in whale abundance in late January and early February. Data gaps are from days with weather conditions too inclement to perform a survey in the boating area.

Ross and Greg have continued collecting fluke photos of humpback whales that can be used for photo-identification and local residency purposes. Whales have continued to show some signs of residency with some whales being spotted in the boating area for multiple days in a short time

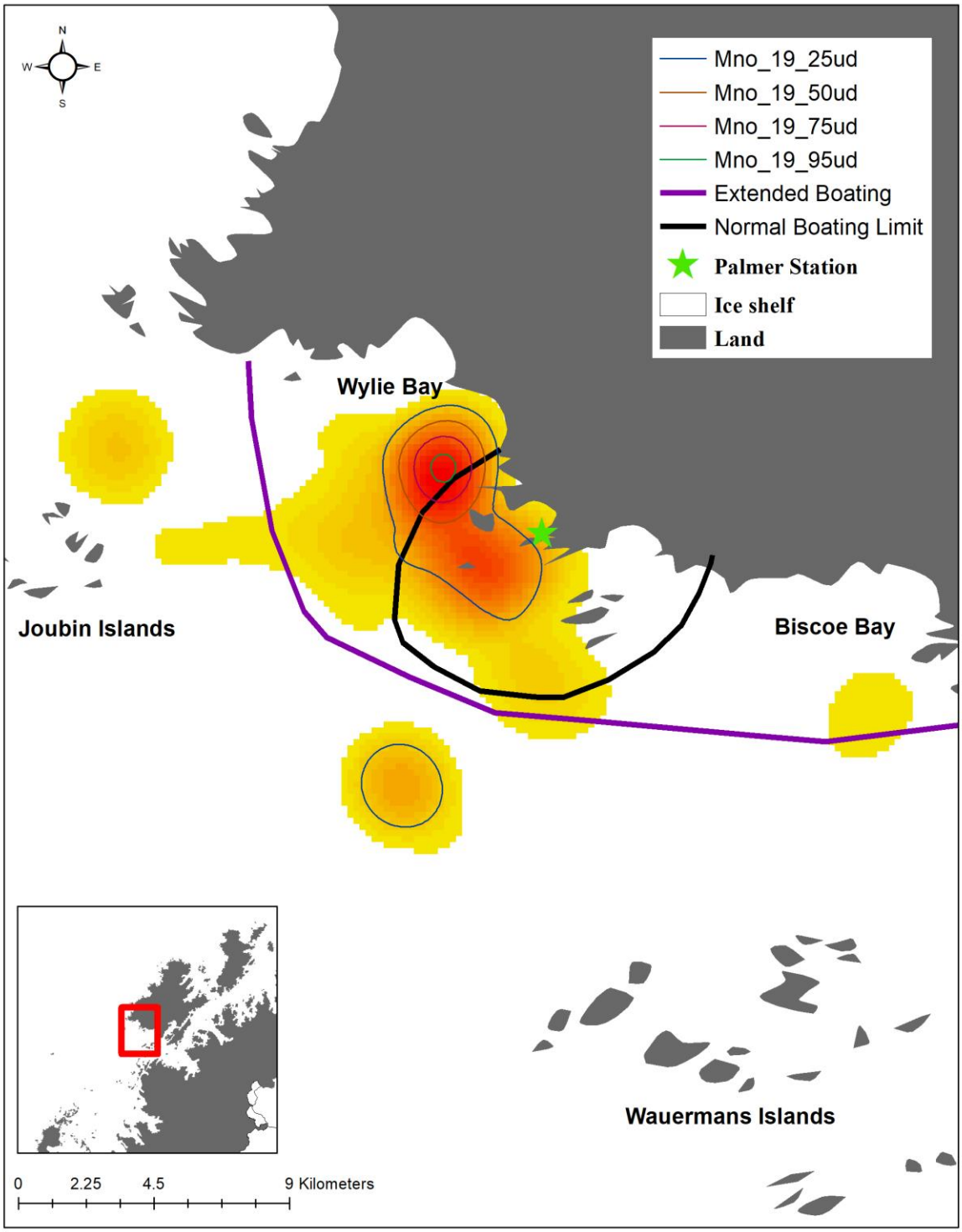

Fig. 12 – Humpback whale sighting locations. For the heat map colors, red indicates greater numbers of humpback whale sightings, while white represents fewer. A clear hotspot for humpback whales this season can be seen in Wylie Bay where foraging humpback whales were seen in huge numbers during late January and early February.

frame. For example, a mother-calf pair (Mn19_038A_P) was seen five times within a period of eight days all within the Northern boating area of Palmer Station. Multiple juvenile whales (Mn19_053NB1_P and Mn19_054NB3_P) and were seen three days in a row foraging around the vicinity of Outcast Island. The juvenile whales were seen foraging and travelling solo, or

with different groups of whales each day. So far, we have collected 240 fluke photos that will be utilized for these purposes.

Extended boating surveys

The C-024-P team at Palmer Station has also completed seventeen surveys in or beyond the extended boating area, which has allowed us to survey a greater spatial extent. These have included trips to the Gossler Islands early in the season, many trips to the Joubin Islands throughout the season while accompanying the C-013-P (Fraser) group, and weekly surveys of the extended boating area. While accompanying other field teams to remote locations, we are able to survey the waters en route to and from those locations, as well as the waters surrounding those locations. These extended survey efforts greatly expand the spatial scope of our understanding of whale habitat around Palmer Station, and critically provide us access to more whales when they are scarce or absent within the standard boating area. This season ASC support staff have been very helpful in facilitating our boating efforts across a greater spatial range, and we are very grateful for the support we have received this year.

The C-024-P project continues to contribute to and benefit from collaborative assistance with ASC personnel and other LTER and NSF funded projects operating at Palmer through coordinated field efforts, shared resources, volunteer assistance, and general advice and support. We thank all those who have facilitated our operations and helped build an exceptionally cooperative climate of research support at Palmer Station this year.

Humpback suction cup tagging operations

Starting 12 February, suction cup tag operations began from Palmer Station for the first time. The tags are deployed using a 5-meter carbon fiber pole from the pulpit of a SOLAS vessel. A safety boat with two personnel aboard accompanied the SOLAS during all tagging operations. The tags stay on the whale (Fig. 13) for 5 to 24 hours before falling off and floating at the surface. The tag then begins transmitting location data via satellite, indicating its location for recovery. A VHF transmitter is also attached to the tag to locate the tag over line-of-sight distances and to enable the tag's location to be pinpointed using a VHF receiver and antenna. With the new access and use of the RHIBs at Palmer Station, the suction cup tags can be tracked into the extended boating areas, a feat that is vital for the retrieval of these tags as the whales are not guaranteed to stay within the boating limits before the tag releases. The suction cup tags are capable of tracking the whale over time by recording its depth, location, and fine-scale movements (Fig. 14). This fine-scale behavioral data can describe in high resolution the foraging behaviors of the whale during each dive. Each lunge feeding event can be seen in the movement data collected from these tags: large changes in acceleration and pitch of the whale are clear indicators that the whale is opening its mouth to engulf a swarm of prey.

These data will be used to determine the fine scale foraging behavior of the humpback whales around Palmer Station and in the Palmer Canyon, and their possible spatial or temporal overlap in foraging habitat with other krill predators. Three suction cup tags were deployed from station, complementing five additional tags that were deployed from the *Gould* during the LTER cruise. During the final tag deployment from Palmer Station, an active acoustic mapping transect was performed with the EK80 echosounder system mounted to a RHIB, which was present as the tagging support boat. The RHIB accompanied the Solas vessel during tagging operations, and a prey-mapping transect followed the deployment of the suction cup tag, by which the EK80

system mapped the local prey field of the tagged and foraging humpback whale. The behavioral recording from the suction cup tag in synchrony with the contemporaneous prey mapping gives us a clear picture of how the humpback whale is foraging and the type of prey field that was being foraged on. This information helps answer questions surrounding the behavioral use of the Palmer area during this vital part of Antarctic humpback whale life history and how humpback whale foraging co-occurs with that of other predators in the near area.

Fig. 13 – A suction cup tag attached to the back of a humpback whale deployed this season. For the tag to have accurate data, it is placed between the blowhole and the dorsal fin to pick up small movements of the head and mouth of the animal as it forages.

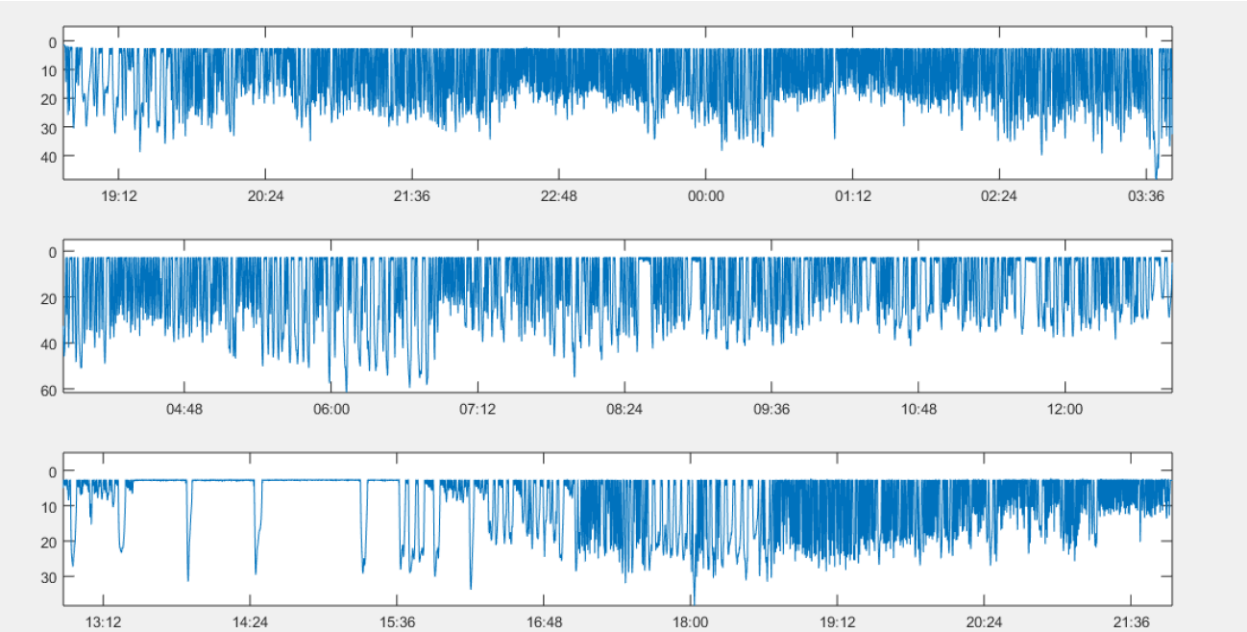

Fig. 14 – A day in the life of a whale. This plot is a 27 hour deployment of a suction cup tag on a humpback whale foraging in the Palmer Deep this season. The y-axis is depth (m), and the x-axis is time of day (local). It is apparent that humpback whales are incredibly active during their stay in the Palmer area and will dive almost constantly throughout the day.

Unoccupied aerial systems operations

The C-024-P (Friedlaender) team's Unoccupied Aerial System (UAS) at Palmer Station had been tabled pending repairs until the LMG 19-02 port call. The hexacopter aircraft had been manifesting navigational issues symptomatic of a broken compass system. During the LMG19-02 southbound port call (20 February), our team was able to repair the drone by replacing all potentially affected parts. Since the repair the drone has performed predictably and consistently, and we have now carried out 29 successful boat-based UAS deployments in the Palmer vicinity. These deployments fall under two categories: whale photogrammetry and pinniped terrestrial habitat mapping.

When wind and wave conditions are suitable for boat-based UAS operations, we deploy our UAS over the whales that we encounter during our survey efforts to collect photogrammetric data. By placing the drone directly over a whale with the camera pointed at nadir with a laser range-finder (here used as a precision altimeter), we are able to capture high-resolution images of whales (Fig. 15) from a distance that is measured to within 1 cm of accuracy. By accounting for lens distortion and measuring the dimensions of the whale's body image in pixels of known area, these images can be used to determine the length and width of a whale. To date this season we have collected photogrammetric data on 27 whales, including two with tissue biopsies.

Fig. 15 – Photograph of a humpback whale at the water's surface on 1 March 2019 in the Palmer boating area, taken from directly over the whale. Using our precision altimetry data with corrections for lens distortion, this image will be used to measure the precise length and girth of this whale. These data will be used to understand how different demographic groups of humpback whales undergo changes in body condition while foraging along the wAP.

While simple in premise, these morphometric data are otherwise difficult or impossible to obtain on-demand, and historically such measurements have been obtainable only from whaling catch

records or haphazard opportunities during surveys from occupied aircrafts. Because UASs can be rapidly deployed during most whale encounters, we are able to acquire these data in unprecedentedly large quantities over the course of the summer foraging season along the Antarctic Peninsula. Such a large dataset will allow us to characterize the range and variability of humpback whale morphology within our population, but more importantly, our temporally explicit sampling throughout each season will allow us to characterize how body condition changes as humpback whales forage in this area, and how these changes differ among demographics - especially for growing calves and their nursing mothers. When these photogrammetry data are combined with our fluke cataloging efforts, we can measure individuals across years and characterize interannual changes in body condition. When these data are combined with our biopsy efforts, we can measure individuals of known sex and pregnancy status and characterize how these demographic statuses correspond to differences in body shape and condition. Future studies are likely to examine cortisol levels in blubber and determine whether stress correlates with trends in body condition. Some of these research questions are most clearly germane to cetacean science and methods, but their application in this location first and foremost will advance our understanding of the whale population along the WAP with respect to its overall health and structure, how this annual foraging period factors into the life history of these animals, and what changes might be observable if and when foraging conditions change.

Beyond still-photography data for whale body measurements, we are also able to record videos of whale behaviors at and just below the ocean's surface while we fly over them (Fig. 16). Such videographic data allow us to characterize and analyze complex behaviors that are rarely

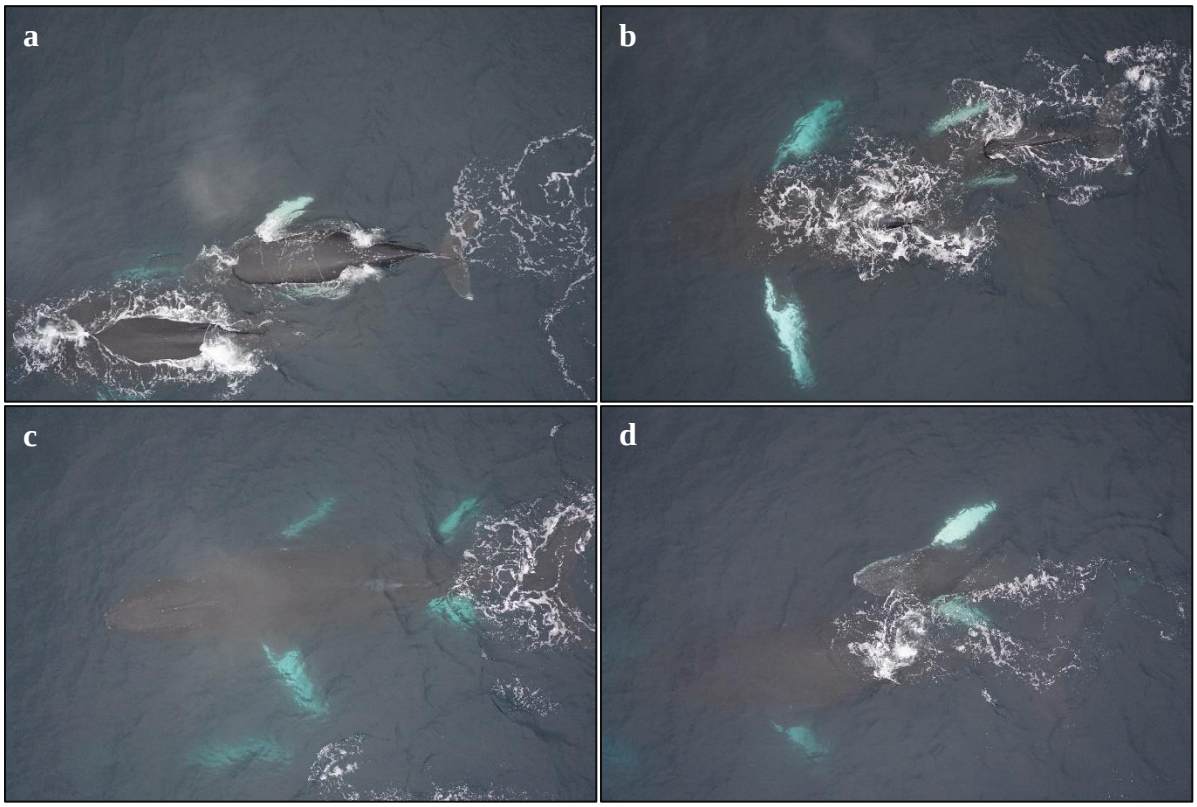

Fig. 16 – A sequence of photographs (in order of lettering) from a fly-over of a mother-calf pair in the Palmer boating area. All frames were captured within a span of 2 minutes and show a calf swimming from (a, b) a position at its mother's right side, to (c) a position approximately below her mammary glands, and then (d) back to the surface again on her right side.

observable from a boat. One particularly exciting example – that would be impossible to see from a zodiac – is the occurrence of probable nursing behaviors between mother-calf pairs. We were able to capture multiple instances of this behavior from multiple mother-calf pairs in both photo bursts (Fig. 16) and a video recording. While we did not observe any milk at the water's surface – which would be the most concrete evidence of nursing – the movements that we have recorded do suggest that nursing was still occurring in late-February, which was previously not known to be the case.

In addition to whale photogrammetry, this year we have also been applying our UAS platform to address ecological questions of the LTER through island mapping missions. The terrestrial habitats of the Palmer Archipelago host many marine species, including pinniped species that are increasingly common near Palmer and are significant predators of the local marine food web. By flying our UAS over these habitats in automated grid-mapping missions, we are able to obtain high-resolution orthomosaics (Fig. 17) and digital surface models (Fig. 18) of the terrain and substrates that comprise these terrestrial habitats, in addition to the position of each animal within these habitats (Fig. 17d). These data can therefore be used to survey both species abundance and species distribution within these islands. Individual surveys can inform how animals associate with specific substrates and with each other, while repeat surveys will allow us to understand how local species abundance and habitat use change over the course of the season. These data can describe not only how a greater number of marine predators use terrestrial habitats near Palmer Station for critical behaviors and life history periods, but also how different species might compete for optimal terrestrial habitats - or partition habitat use spatially or temporally.

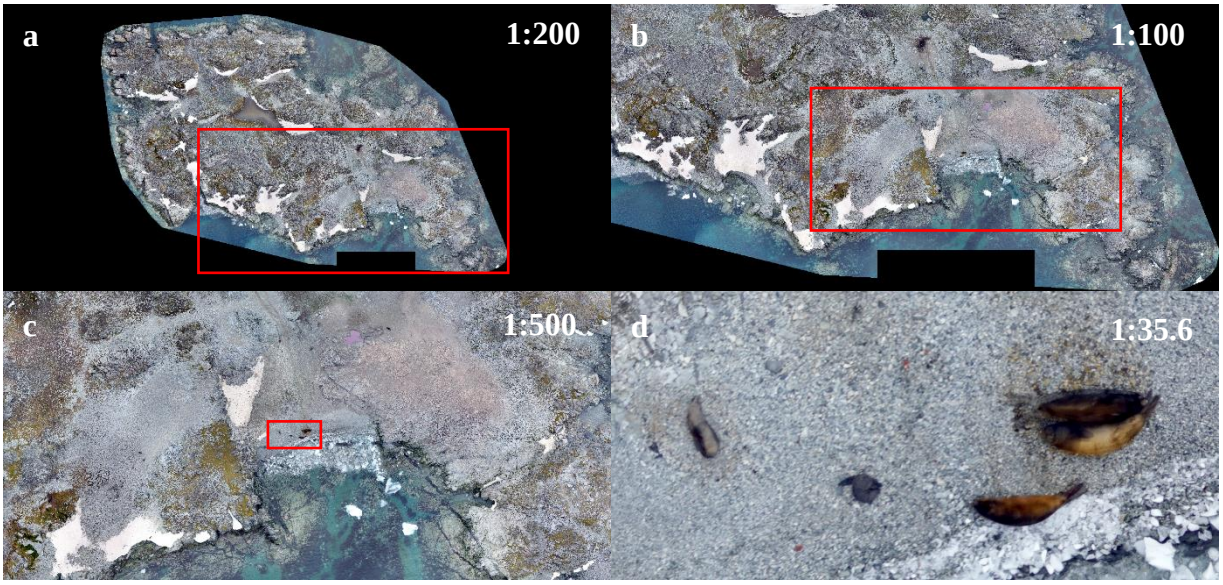

Fig. 17 – An unedited first orthomosaic data product from the 23 February UAS mapping survey of Humble Island. Each panel shows (a) the entirety, or (b, c, d) a subsection (outlined in red in each preceding panel) of the orthomosaic at increasingly fine scale. Each pixel in the complete mosaic represents 1 square centimeter of ground cover.

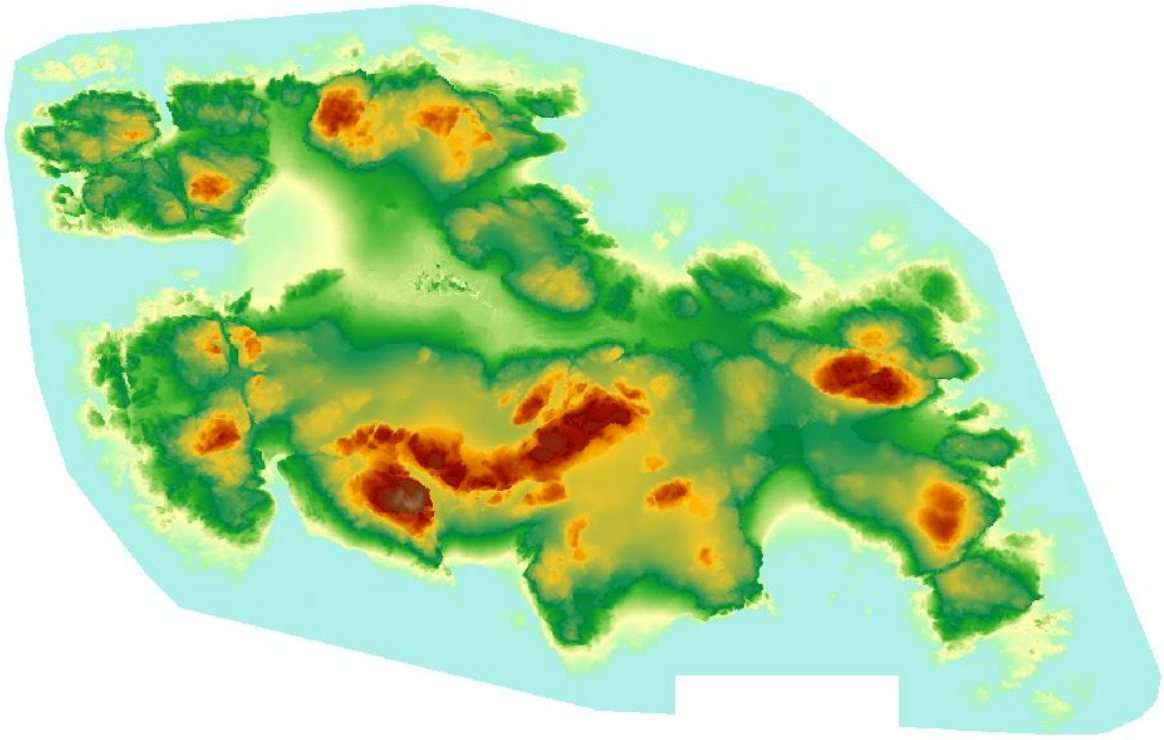

Fig. 18 – An unedited first digital surface model data product from the 23 February mapping survey of Humble Island. These high-resolution elevation data will be used to describe the topography of pinniped terrestrial haul out habitat on Humble Island.

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

Things kept going smoothly in February and plenty of samples have been collected throughout the month. Long-term sampling at Stations B and E continued twice a week (8 times in total in February), collecting samples of nutrients, 18O, fixed flow cytometry, and DNA.

As in January, DNA/RNA diel samples were collected every day at mid-day and mid-night from the pump house intake at Palmer Station, to analyze the daily shifts of microbial community structures in seawater. Supplementary molecular samples were collected occasionally, with larger filtration volume (>10 L), which could provide higher sensitivity to examine the existence of N_2 fixation marker genes. All these molecular samples were preserved at -80℃ until further analysis.

The EIMS (Equilibrator Inlet Mass Spectrometer), which measures net community production through O_2/Ar ratio, encountered some technical problems in the middle of the month. Things

came back on track after the filament and the flowmeter were replaced. The O_2/Ar was over saturated at the beginning of the month when a bloom was observed, indicating high net community production in the water column. After the bloom, the O_2/Ar dropped to under saturation, indicating lower net community production and a heterotrophic status in the water.

N_2 fixation measurements were conducted throughout the month. As the N_2 fixation signal was always below the detection limit of the FARACAS (Flow-Through Incubation Acetylene Reduction Assays by Cavity Ring Down Laser) system, efforts were focused on the $^{15}N_2$ incubation experiments. The frequency of incubation was raised from once a week to every 2-3 days. Samples were collected and preserved for further analysis. Meanwhile, the FARACAS will be set into discrete mode once the leakage issue is fixed, which will allow us to conduct more measurements on discrete samples.

PALMER STATION
RESEARCH ASSOCIATE MONTHLY REPORT

February 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. The ELF antenna was shut down for 32 hours to dry out the interior of the ELF shelter.

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 was turned back on with the return of darkness. The system has experienced some brief issues with a Windows 10 update, but has returned to normal operation.

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. Preparations are underway to breakdown and ship out this project next month.

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. Ten boxes of air flasks were received on LMG19-02 for the winter months.

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. Four crates of CCGG flasks and one crate of HATS flasks were received on LMG19-02.

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. One power supply encountered an issue maintaining temperature and blew a fuse. Troubleshooting is still underway. 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.

System hung twice and also started recursively sending data, but both issues were resolved and the system otherwise operated normally throughout the month.

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 hung once, but otherwise 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. A command request filter sample was shipped north on LMG19-01. Next year's filter rolls and replacement parts were received on LMG19-02.

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. The Research Associate provided sea temperature data for the pier rebuild planning team.

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 Backyard weather tower was replaced with a safer, climbable Rohn tower on 28 February, which resulted in a six hour weather station outage. Provided air temperature and wind speed data for the pier rebuild planning team. Observations are archived on the AMRC website: ftp://amrc.ssec.wisc.edu/pub/palmer/.