Regional Operations Centre
Canadian Coast Guard – Pacific

PACIFIC REGION CCG VESSEL - POST CRUISE REPORT
Line P Program – Fisheries and Oceans Canada

NAME OF SHIP/PLATFORM: John P Tully

DATE: **FROM:** 4 June 2017 **TO:** 20 June 2017

SCIENCE CRUISE NUMBER: 2017-06 **SHIP'S PATROL NUMBER:** 17-03

CHIEF SCIENTIST[S]: Marie Robert

SCIENTIFIC PERSONNEL:

Female	Male
Lindsay Fenwick (UBC)	Michael Arychuk (IOS)
Marie Robert (IOS)	Mark Belton (IOS)
Jade Shiller (UBC)	Patrick Berk (NOAA)
Amanda Timmerman (UVic)	Glenn Cooper (IOS)
Theresa Venello (UVic)	Mike Craig (NOAA)
	Robert Izett (UBC)
	Connor Morgan-Lang (UBC)
	Richard Nixon (IOS)
	Yuanheng Xiong (UND)
	Doug Yelland (IOS)

AREAS OF OPERATION: North East Pacific, Line P, Station P.

INTRODUCTION/PROGRAM BACKGROUND: Line P is a long standing program which surveys a 1400 km long section 3 times annually. Data have been collected along this line since 1956 and show evidence of the impact of climate variability on ocean productivity. It is the only Canadian long time-series that allows scientists to monitor climate changes in the Pacific Ocean. It is also the best opportunity for other programs (e.g. Universities) to do research in the Pacific since the Line P data give them background as well as current water properties.

CRUISE OBJECTIVE/OBJECTIVES: Repeat hydrography section (physics, chemistry, zooplankton), deploy four Argo floats for IOS, deploy 10 drifters for NOAA, recover NOAA mooring PA-010, deploy NOAA mooring PA-011, deployment a mooring near Explorer Seamount, do an acoustic survey of Union Seamount.

CRUISE DESCRIPTION: This cruise (2017-06) went really well. The weather was good most of the time. We had a day of rougher weather at P12, preventing us from deploying the Explorer Seamount mooring, but we simply did that deployment on the way back. Similarly the plan at Papa had to be adjusted to the weather since on the day we were planning to deploy PA-011 the seas were a little too high for mooring work. Fortunately

rosettes and go-flo casts were still very feasible, so following a different plan we ended up doing all the work before heading east again. Problems with the new NOAA mooring kept us at Station P for a further 24 hours but fortunately we could afford that extra day. Of the extra work we were supposed to do, as previously mentioned we did deploy the Explorer Seamount Acoustic mooring, but we only had time to sail one of the eight lines of the Union Seamount Acoustic survey.

DAYS ALLOCATED: 16 **DAYS OF OPERATION:** 15

DAYS LOST DUE TO WEATHER: about ¼ day.

SAMPLING:

- The Line P survey was 100% successful. All stations were visited and all standard casts were performed. We only missed the deep (1200 m) bongos at P8 and P12, but these are not part of the basic Line P work.
- 4 Argo floats were deployed for IOS and 10 drifters were deployed for NOAA.
- Trace Metal samples were collected using the Go-flo bottles on the Kevlar line; the pump was not used for this cruise.
- The samples collected include:

  1) Underway: **IOS**: Thermosalinograph (Temperature, Salinity, Fluorescence), acoustic sounder, ADCP, pCO_2 – **UBC (Izett):** FRRF (photosynthesis efficiency), MIMS (O_2, Ar, N_2, DMS, CO_2, H_2O), PIGGY (O_2, total gas tension ~N_2), OPTICS (backscatter, absorption, attenuation).

  2) "E-data" from CTD: Pressure, Temperature, Conductivity, Dissolved Oxygen, Transmissivity, Irradiance, Fluorescence.

  3) From the Rosette: **DFO-IOS:** dissolved oxygen, salinity, nutrients, DMS, DMSP, chlorophyll, pigments (HPLC), dissolved inorganic carbon (DIC), alkalinity, pH, DOC – **UBC (Shiller, Morgan-Lang):** high-resolution bacterial DNA sequencing, number of cells per millilitre, single cell DNA analysis, virus analysis, viral counts – **UBC (Izett, Fenwick):** methane and nitrous oxide (N_2O), carbon-14 (^{14}C) uptake experiments – **UVic (Timmerman):** ONAr, dissolved oxygen, triple oxygen isotope, dual tracer incubations, NH4, nutrients, chlorophyll, trace metal, salinity, phytoplankton, noble gases – **UVic (Venello):** secondary productivity, zooplankton, 'bugs' (for E. Pakhomov, UBC) **– U. North Dakota (Xiong):** optics: volume scattering function, particle size distribution.

  4) **DFO-IOS and UVic (Yelland, Venello):** Zooplankton using vertical net hauls (Bongo to 250 m and 1200 m, and single fine-mesh net to 250 m).

  5) From the Go-flo: **DFO-IOS (Nixon):** Dissolved (0.22 µm filtered) and total dissolvable (unfiltered) iron, copper speciation, iron speciation (for M. Maldonado, UBC), nutrients, salinity.

RADIOISOTOPE USE:

C^{14} was used. The rad van was in good working order. The Rad-Van got decommissioned at the end of the cruise and approved by Michael Arychuk, RSO on board.

PROBLEMS [SCIENTIFIC GEAR AND OPERATIONS]:

The transmissometer on the main rosette (S/N 1201) wasn't working properly. No data below about 100 m will be useful. Even though this was discovered during the previous cruise (La Perouse cruise, 2017-05), no other working transmissometer was available to replace this one. The transmissometer that was sent as a spare was the same one that was used on the February Line P cruise (2017-01, S/N 1185). That instrument was malfunctioning in February, and despite having not been fixed yet it was still sent as a spare.

There is a piece of copper pipe in the new thermosalinograph set-up. Not only is it a bad idea to use copper when you look at biological properties, this piece of copper pipe is set-up just before the fluorometer.

The PAR sensor that normally goes on the helideck to measure light around the incubators wasn't working, therefore we have no PAR reading for this cruise. Hopefully the new weather station can be installed prior to the August cruise.

Once deployed, all the subsurface instruments of the PA-011 mooring stopped communicating. We had to recover PA-011, swap many components with spares, and redeploy.

Sometime on Friday 16 June the flow meter of the thermosalinograph stopped functioning. The flow still seems the same, but unfortunately there's no way of measuring it now.

SUCCESSES [SCIENTIFIC]:

The loading went really well. Thanks to Doug Yelland, chief scientist on the previous cruise (2017-05), for allowing us to load the containers and some of our Line P equipment at the beginning of his cruise. The IOS Open House happening during our loading day – June 4 – it greatly simplified the Line P loading.

PROBLEMS [SHIP'S EQUIPMENT/OPERATIONS/PLATFORM SUITABILITY]:

This mooring cruise is the prime example that we need a "General Science" email account to conduct operations while at Station Papa. Some instruments on the mooring PA-011 stopped transmitting after the first deployment, and other instruments were not set-up properly. The NOAA office contacted the mooring technicians on board via the Senior Engineer's email account, and this shows the importance of communications while west of ~136°30 W, where we normally lose contact with the satellite. Many thanks to Sheroy Mistry for allowing us to use the Senior Engineer's email account.

Many aft cabins, as well as the instrument (temperature controlled) lab, got water coming up through the deck drain. We were told that there was too much loop water going into the lab sink, but we were not using any more water than during past cruises. We encountered the same overflow problem in previous cruises but the issue is getting worse. Only the most aft cabin (cabin H) used to have that issue. Then cabin G was also affected. During this (June) cruise, cabins all the way to Cabin D got their drain to overflow. Hopefully the drain issues can be addressed during the next out-of-service period.

The bridge sounder causes interference with our science sounders. The Captain and officers asked us to set-up a computer on the bridge so that they could VNC into our sounders and see the water depth. Unfortunately that computer is a Windows XP machine, and does not have administrative privileges on it. The computer would go in stand-by mode every 15 minutes, requiring to "physically push a button" to get it out of stand-by mode and re-set the VNC connection every time.

SUCCESSES [SHIP]:

The Internet-at-Sea system worked wonderfully during this cruise, until we lost contact with the satellite around P18 (136°40W). It was definitely much better than during the La Perouse program cruise, 2017-05, immediately preceding Line P (23 May – 4 June).

A new net was installed in the chains. With this net, the use of the retractable "leashes" is not necessary anymore in good weather which greatly improves the easiness of movement while doing trace metal sampling, as well as not obstructing the circulation in the breezeway anymore.

We used the new DMS container on the aft-deck. The new setup puts the compressed air cylinders inside the container. There already was a system in place to secure those tanks, but the crew greatly improved the set-up and now the tanks are really secure. Thanks!

During this cruise, some rosette casts had to happen two hours before local sunrise. Many thanks to Captain Gronmyr for using both engines when necessary so that these casts could be performed at the right time of day. When missing sunrise by only a few hours, it's a long wait for the following one!

DELAYS [OTHER THAN WEATHER]:

Two afternoons for fuelling, a few hours for a SAR call on 4 June.

SAFETY CONCERNS:

None

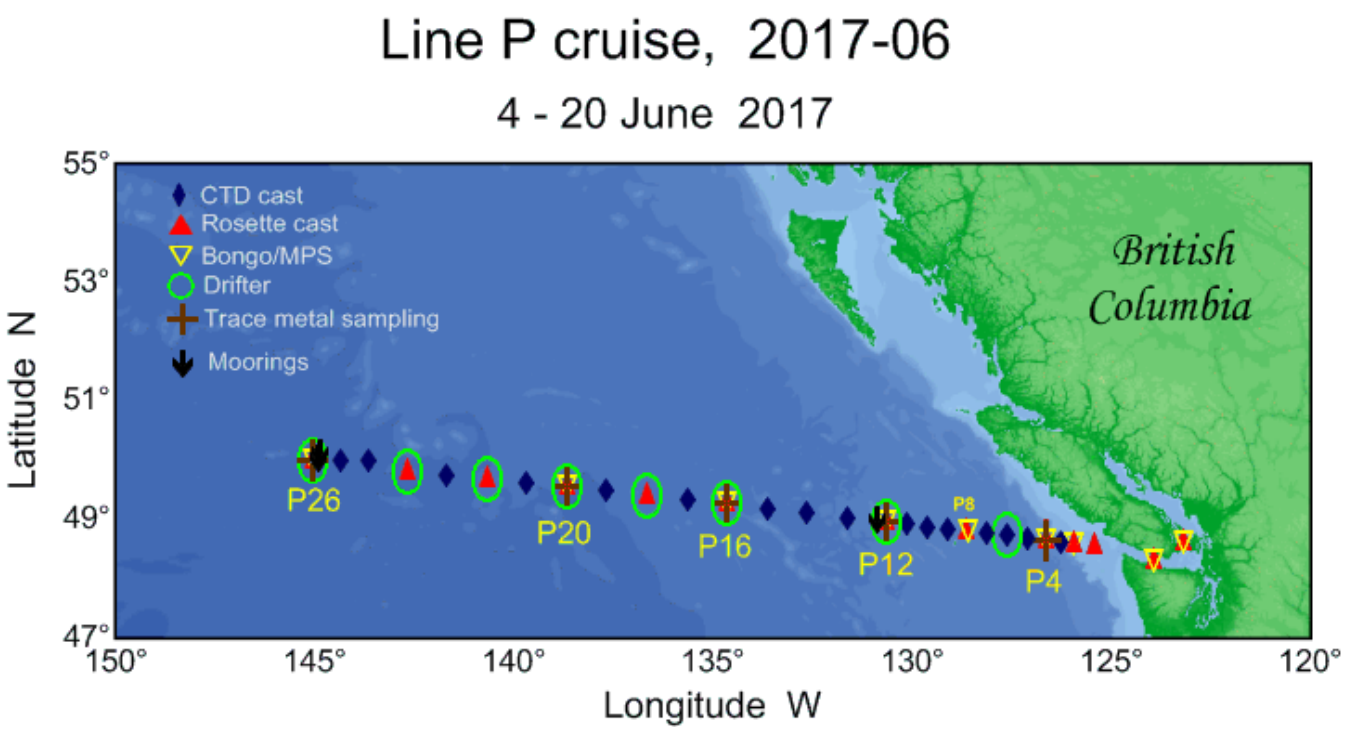
HAZARDOUS OCCURRENCES:

One employee suffered some severe sea-sickness during the first three days of the cruise but fortunately managed to recover.

EVENT LOG:

Sunday 4 June:	Start loading scientific equipment around 0730. Fuelling from lunch to dinner time. Safety meeting 1600. Science meeting 1800. Departure at 1900. Station Haro 59. Short SAR call.
Monday 5 June:	Stations JF2 to P4. Fire drill at 1300.
Tuesday 6 June:	Stations P4 to P8. Deploy Argo float at P6.
Wednesday 7 June:	Stations P9 to P12. Somewhat bad weather. Deploy Argo float at P12.
Thursday 8 June:	Stations P13 to P16. Deploy NOAA drifters at P16.
Friday 9 June:	Stations P16 to P19. Deploy NOAA drifter and Argo float at P18.
Saturday 10 June:	Stations P20 to P22. Deploy NOAA drifters and Argo float at P20, and NOAA drifter at P22.
Sunday 11 June:	Stations P24 to P35. Deploy NOAA drifters at P24.
Monday 12 June:	Go to NOAA mooring PA-011 deployment site. Weather too rough for mooring work. Go to Papa and do most rosettes and all Trace Metal casts.
Tuesday 13 June:	Station P26: last rosette casts and all bongos. Deploy NOAA drifters. Head to PA-011 and deploy mooring in the afternoon. Calibration cast. Find out in the evening that there are problems with some instruments on the mooring.
Wednesday 14 June:	Recover PA-011 in the morning, and re-deploy in the afternoon. Calibration cast.
Thursday 15 June:	Recover PA-010 mooring. Re-visit PA-011 site to update one sensor. Start heading east.
Friday 16 June:	Heading east
Saturday 17 June:	One line of the Union Seamount acoustic survey. Deploy Explorer Seamount Acoustic mooring.
Sunday 18 June:	40 m Go-flo at P4. Water sampling at JF2.
Monday 19 June:	Back to IOS. Offload in the morning, fuel in the afternoon.

CRUISE TRACK:



SUMMARY/FINAL COMMENTS:

- Many thanks to everyone at IOS who have helped make this cruise a success: Kenny, Nina, Kelly, Moira, Tamara … your help is always greatly appreciated! Thanks for the extra hand (and backs!) while offloading.

- Thanks to Doug Yelland for allowing us to load the containers and some of the Line P equipment before the La Perouse cruise.

- Thanks to all the "DIC samplers, picklers and tapers".

- Thanks to the entire galley crew for keeping us so well fed, and for a great BBQ. Very special thanks to Sheila and Vince for dealing with all our "put-aways" and all our other little requests. You guys are fantastic!

- Thanks to Captain Gronmyr for the extra speed when needed, especially when it allowed us to reach a station on time for the "before sunrise" cast so that we didn't have to wait all day for darkness to come back. That had a very important impact on data. Thank you too for staying the extra day at Papa in order to 'fix' the PA-011 mooring.

- And speaking of mooring work: a very special thank you to the crew members who had to modify their watch (and sleeping pattern) and who did three long days of work on the half-deck. We wouldn't have our data without you guys (and gal!).

- Finally thanks to the engine room staff for dealing with our "on" and "off" (retention) requests, and for the officers up on the bridge for getting us on station so efficiently. And a very special and big Thank You to Sheroy Mistry to allowing us to use the Senior Engineer's email account while out of internet range.

  I guess it'll be a while until we sail with you guys again; take care and to August 2018! ☺

  Marie Robert

- We'd like to thank the captain and crew of the *Tully* for their assistance, excellent work, and willingness to work around the clock and through all weather. Thanks to the IOS team and our fellow scientists for their help and their humour on deck and in the lab. And finally, a great big thank-you to Marie for flawlessly organizing the entire cruise and for smiling through the endless schedule revisions that are inevitable to fieldwork.

  Jade Shiller and Connor Morgan-Lang

- As always, it was a pleasure to be involved in this cruise, and to work with our colleagues. We <u>greatly</u> appreciate all of the help we received – particularly in accommodating our objectives (thanks very much Marie!) and instrument setups, the additional efforts to collect and analyze Winkler O_2 calibration samples (thanks Mark!), and in overseeing the process of conducting radioisotope work on the ship (thanks Mike!). We thank the entire crew of the Tully for their great assistance, and for taking such good care of us – as always.

  Robert Izett and Linsday Fenwick

- We would like to thank all of those who assisted in the collection and preservation of the DIC/Alk samples. Your help was truly appreciated.

  Glenn Cooper

- This is my privilege to join the Line P cruise. I would like to thank the entire crew of the *Tully* for their assistance, patience, and kindness, with special thanks to Jimmy and Bruce, who specifically helped me with relocating and storing my heavy and large packages. I also want to thank the IOS team for arranging this cruise so well and the entire science team for helping me countless times on *Tully*, with special thanks to Mike, who helped me greatly for loading and setting up the entire gears, and Marie, who guided me from the first beginning and made extra effort to ensure my unique sampling wishes were realized. I couldn't do it without all of their help.

  Yuanheng Xiong

- We'd like to thank the Captain and crew of the *Tully* for all their assistance and hard work throughout the cruise. Thanks to Marie Robert and the IOS science crew for having us on board to do this work and accommodating our sampling needs.

  Theresa Venello

- Thank you to everyone for making my last Line P cruise as a PhD student successful. Thank you especially to Marie for her support and accommodating my sampling requests, Glenn and Theresa for helping with the incubator, IOS personnel for analyzing samples and Sarah Thornton for providing science equipment. I also want to thank Mark, Robert, Theresa and Conor their help sampling. Thank you to the Captain, officers and crew of the JP Tully.

  Amanda Timmerman

- Many thanks to the captain and crew of the Tully who performed above and beyond for safe and successful operations. We thank everyone for their flexibility and understanding when our project hit a serious snag. Special thanks to Chief Scientist Marie Robert for graciously sacrificing some of her planned work to enable us to successfully repair our mooring. Also thank you to Amanda Timmerman from UVIC for handling all CTD water sampling on behalf of UW and PMEL.

  Patrick Berk and Michael Craig

PROJECTS AND RESULTS:

Water masses – Marie Robert, DFO/IOS.

The weather during this cruise has been very nice. There were two days of stronger winds, both while we were at P12 (outbound and inbound), but in general we made good speed and did not have to cancel much work because of weather – only the deep bongo at P12. The water temperature along Line P seems to slowly be getting closer to long term averages. In August 2016 the waters were still very warm following the presence of the "Blob". This June some subsurface areas of warm water remain, between ~100 and ~300 dbar, but cooler than average water can be seen at the surface a little more than half-way to station Papa. (See figure 1). Unfortunately we only had time to sail one of the eight lines of the Union Seamount acoustic survey, but the line we did gave us a pretty nice picture of the seamount. (See figure 2).

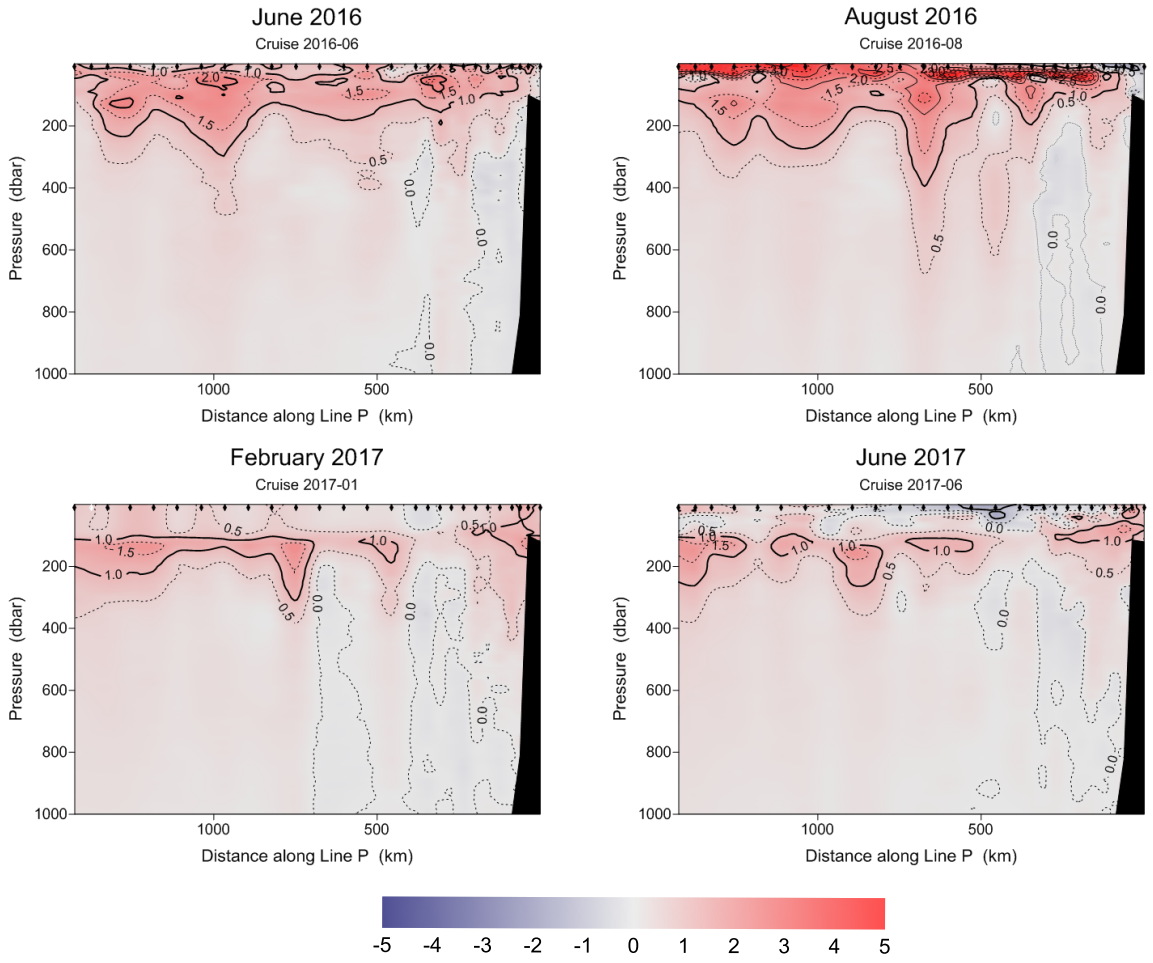


Figure 1: Temperature anomaly field with respect to the 1956 – 1991 averages for June 2016 (top left panel), August 2016 (top right panel), February 2017 (bottom left panel), and June 2017 (bottom right panel). The warm anomaly seems to be getting much smaller and much deeper with time. Please note that the February and June 2017 data are not processed.

Figure 2: Line 1 of the Union Seamount acoustic survey.

pCO2 system – Michael Arychuk, DFO/IOS.

The PCO_2 system generally worked well this cruise with a few minor glitches. For some reason the system froze at Papa. Once re-started it stopped for no reason about 12 hours later. It is difficult to know whether the problem was with the laptop, software, hardware or external because the problem was intermittent and did not occur again. Also, similar problems were experienced by another instrument nearby so there is a possibility the problem was external or human error. There was no AVOS data collected by the system this cruise but Doug Yelland did get AVOS operational and the data was logged on another computer. When required, he will need to be contacted to supply the data file. There was also a problem with the internal water flow meter as it stopped working at the beginning of the cruise. This was not a major issue as the system does have a back-up, external flow meter that regulates the flow of the water to the equilibrator. Finally, the internal temperature issue with the PCO2 system is still unresolved and for the time being that particular parameter will have to be extracted from the TSG file. Marie Robert is working on a solution and hopefully by next year the PCO2 system will be able to collect the internal temperature as part of the data set.

Hallam lab, UBC (Jade Shiller and Connor Morgan-Lang) – June 2017 Line P

Objectives:
Describe the taxonomic and metabolic diversity of the bacterial and viral communities in the cycling of major nutrients along Line P, focusing on the communities in the oxygen minimum zone.

Sampling summary:
At 5 stations (P4, P12, P16, P20, and P26),

1) 2 L seawater samples (at 16 depths) for high-resolution (HR) bacterial DNA sequencing were filtered.
2) 50 mL seawater samples were taken per depth to count microbial population density using flow cytometry and single cell DNA analysis. Samples were aliquoted and preserved using glutaraldehyde and glycerol+trisEDTA, respectively.

Additionally, at 3 major stations (P4, P12, and P26), the following were sampled at four depths: 10, 500, 1000, and 2000 (bottom+10 at P4) across the oxygen minimum zone:

1) Large volumes (20 L; LV) at each depth were filtered to create genomic libraries of the bacterial communities.
2) After adding iron chloride to the filtered water, the samples were filtered again for later virus analysis.
3) For viral counts, samples were taken and preserved using glutaraldehyde and betaine. Filtered seawater was also collected without preservatives in order to isolate and culture viruses in the lab.
4) 50 mL seawater samples were collected per depth to count microbial population density using flow cytometry and single cell DNA analysis. Samples were aliquoted and preserved using glutaraldehyde and glycerol+trisEDTA, respectively.

Comments:

All of our sampling objectives for this cruise were successfully fulfilled. The work area distribution was convenient for our sampling needs.

We'd like to thank the captain and crew of the *Tully* for their assistance, excellent work, and willingness to work around the clock and through all weather. Thanks to the IOS team and our fellow scientists for their help and their humour on deck and in the lab. And finally, a great big thank-you to Marie for flawlessly organizing the entire cruise and for smiling through the endless schedule revisions that are inevitable to fieldwork.

Cruise Report – Robert Izett & Lindsay Fenwick (Tortell Lab; UBC, Earth, Ocean & Atmospheric Sciences)

Objectives:

Our participation in this cruise was focused on quantifying the distribution of biogenic gases and optical properties in surface and subsurface waters along the Line P transect. We continued our deployment of automated instruments for underway analysis, and collected discrete depth profile and surface samples for subsequent laboratory analysis. A key aim of these efforts was to quantify primary productivity (NCP and NPP) at high resolution along the Line P transect – contributing to previous efforts over the past 2 years. We additionally conducted carbon-14 (^{14}C) uptake experiments to evaluate gross primary productivity at the major stations.

Gas Measurements and Quantification of Net Community Production:

At the major stations (P4, P8, P12, P16, P20, and P26) we collected discrete profile samples for analysis of methane and nitrous oxide (N_2O), contributing to our time-series (almost-ten years) of these gases along the Line P transect. Surface (5 m Niskin) samples were collected for N_2O analysis at every station. Additional samples were collected from the lab seawater loop system for comparison between loop and Niskin samples (samples were drawn from the loop at approximately the same time as the 5 m Niskin was fired), and to improve the resolution of surface measurements (samples collected underway between stations). Data from last August suggest that the difference between paired loop and Niskin samples is not statistically significant.

We deployed a membrane inlet mass spectrometer (MIMS) for underway measurement of mixed layer gas concentrations of dissolved nitrogen, oxygen, carbon dioxide, argon, and DMS. Of particular interest was the ratio of O_2/Ar, which enables quantification of surface ocean net community production (NCP). The discrete N_2O profile and surface samples will be used to correct underway O_2 and NCP measurements for the upward advection of low-O_2 water.

We also continued our deployment of the Optode/Gas Tension Device (GTD) setup ("Miss Piggy") in the transducer space. Using these instruments, we derive underway O_2/N_2 data, which can also be used to quantify NCP. However, since Ar is a better analog for O_2 than N_2, we will be assessing the suitability of replacing O_2/Ar measurements with O_2/N_2 for calculations of NCP. Our goal on subsequent cruises is to phase out the MIMS system and replace it with the more cost-efficient and simpler Optode/GTD system.

Like last year, we calibrated the optode using discrete samples (analyzed for O_2 by Winkler titration) collected from Miss Piggy in the transducer space. These measurements will also be compared against the 5 m Niskin to observe the offset between Niskin and loop sampling.

Optical Instrumentation:

We continued our measurement of optical properties from the seawater loop, including particulate back-scatter and spectrally-resolved absorption/attenuation spectra. These measurements will be used to derive particulate carbon concentrations and net primary production rates. Discrete filtration samples for spectral analysis were also obtained at each station. The FRRF was run for underway measurements of phytoplankton photosynthetic efficiency (used as a proxy for nutrient stress).

^{14}C Experiments:

We conducted ^{14}C uptake experiments (24-hr incubation) for quantification of mixed layer primary productivity at the major stations (P4, P12, P16, P20, and P26).

Comments:

We experienced no major instrument issues, and collected high quality data sets from each underway system.

As always, it was a pleasure to be involved in this cruise, and to work with our colleagues. We greatly appreciate all of the help we received – particularly in accommodating our objectives (thanks very much Marie!) and instrument setups, the additional efforts to collect and analyze Winkler O_2 calibration samples (thanks Mark!), and in overseeing the process of conducting radioisotope work on the ship (thanks Mike!). We thank the entire crew of the Tully for their great assistance, and for taking such good care of us – as always.

June 2017 Line P Cruise Report – Trace Metals – Richard L Nixon, UVic / IOS

My primary objective for this cruise was to collect samples for the ongoing Line-P Iron Time Series project, a component of the Trace Metal Biogeochemistry Program at the Institute for Ocean Sciences in Sidney, BC and a Process Study endorsed by GEOTRACES. Dissolved and total iron levels along the Line-P transect have been measured since 1997 in an effort to characterize biogeochemical cycling of iron in waters of the British Columbian coast and Alaskan gyre. These data are used by the Department of Fisheries and Oceans to understand the impacts of anthropogenic and natural inputs of iron upon fisheries and marine ecosystems, including iron fertilization experiments and the ongoing effects of climate change.

An effort was made at all stages of sampling and collection to avoid introducing metal contaminants into sampling devices or sample bottles. Three of the sampling devices (Niskins #6, 10, 12) were leached of metals with hydrochloric acid prior to the first cast. One of the sampling devices (Goflo #7) was persistently leaky; this device was not acid-cleaned. Devices were attached to a Kevlar line in the 'open' position and brought to their appropriate depths for each cast. Lead weights were attached 50 m below the deepest sampling device. Messenger weights were attached on the upper three devices and a fourth messenger was dropped down the line to sequentially trigger each device to close at the assigned depth. Unexpected scheduling conflicts precluded sampling at station P4. RBRs were attached to each sampling device to measure the actual depth at which water was collected: RBR-1, go-flo #7; RBR-2, niskin #12; RBR-3, niskin #6; RBR-4, niskin #10. Data from these RBRs has not been analysed yet.

Fe_{Total} samples were collected at twelve depths per station in trace-metal-clean 250mL or 500mL bottles using a sampling bell attached to the spigot of each Niskin/Goflo. Bottles were rinsed four times with sample water before filling. Samples were stored at room temperature.

dFe samples were collected at twelve depths per station in trace-metal-clean 250mL or 500mL bottles by attaching a sampling bell and a 0.22um opticap XL capsule filter (Millipore) to the spigot of each Niskin/Goflo. Several capsule volumes of sample water were passed through the filter before rinsing each bottle four times, filling, and storing at room temperature. Iron samples were not acidified on board as I did not feel confident in my ability to maintain trace metal cleanliness within the wet laboratory. Duplicate 10m samples were taken at each station.

Fe speciation samples were collected in trace-metal-clean 500mL bottles at P16 (7 replicates at 25m, 5 replicates at 40m) and P20 (8 replicates at 25m and 40m, 10 replicates at 800m) using a sampling bell and 0.22um filter. Bottles were rinsed four times, filled, and frozen at -20C.

Cu speciation samples were collected in triplicate in trace-metal-clean 1L bottles at nine depths at P26 using the same protocol as Fe speciation.

Salinity and nutrient samples were collected at each station at 40m, 150m, and 800m. Sample bottles (glass salinity bottles, plastic nutrient tubes) and their caps were rinsed three times before filling with unfiltered water collected using a sampling bell. Nutrient samples were immediately frozen. Salinity samples were stored at room temperature.

Times reported for each event reflect when the messenger was dropped (in PST).

Station	Cast details	Device #	Depth	Sample #	TM samples taken
P12	Event 35 48˚58.25N 130˚40.10W 06/07 4:00PM	12	5 m	213	dFe, Fe_{Total}
		10	10 m	216	
		6	25 m	215	
		7	40 m	214	
	Event 37 48˚58.23N 130˚40.07W 06/07 6:30PM	6	50 m	244	
		7	75 m	243	
		10	100 m	242	
		12	150 m	241	
	Event 39 48˚58.22N 130˚40.04W 06/07 9:45PM	10	200 m	246	
		7	300 m	248	
		6	400 m	247	
		12	800 m	245	

P16	Event 47 49˚17.07N 134˚40.00W 06/09 12:30AM	7	5 m	319	
		12	10 m	318	
		10	25 m	317	dFe, Fe_{Total}, Fe speciation
		6	40 m	316	
	Event 50 49˚16.33N 134˚40.30W 06/09 3:25AM	7	50 m	323	dFe, Fe_{Total}
		12	75 m	322	
		10	100 m	321	
		6	150 m	320	
	Event 52 49˚16.60N 134˚39.78W 06/09 5:30AM	6	200 m	342	
		10	300 m	341	
		7	400 m	340	
		12	800 m	339	
P20	Event 63 49˚33.94N 138˚39.84W 06/10 5:00AM	7	200 m	400	
		12	300 m	399	
		6	400 m	398	
		10	800 m	397	dFe, Fe_{Total}, Fe speciation
	Event 66 49˚33.86N 138˚40.30W 06/10 9:35AM	12	50 m	428	dFe, Fe_{Total}
		6	75 m	427	
		7	100 m	426	
		10	150 m	425	
	Event 68 49˚34.22N 138˚40.70W 06/10 11:19AM	7	5 m	432	
		6	10 m	431	
		10	25 m	430	dFe, Fe_{Total}, Fe speciation
		12	40 m	429	
P26	Event 86 50˚00.00N 144˚59.98W 06/12 2:06PM	12	200 m	553	dFe, Fe_{Total}, Cu speciation
		7	300 m	552	dFe, Fe_{Total}
		10	400 m	551	dFe, Fe_{Total}, Cu speciation
		6	800 m	550	
	Event 89 50˚00.00N 144˚59.98W 06/12 4:21PM	7	50 m	549	dFe, Fe_{Total}
		10	75 m	548	dFe, Fe_{Total}, Cu speciation
		6	100 m	547	
		12	150 m	546	
	Event 90 50˚00.00N 144˚59.98W 06/12 6:55PM	12	5 m	545	
		7	10 m	544	dFe, Fe_{Total}
		6	25 m	543	dFe, Fe_{Total}, Cu speciation
		10	40 m	542	

Cast	Commentary
Event 35	Before dropping the messenger, the line was raised to align sample 213 with the surface and then dropped 5 m.
Event 37	Before dropping the messenger, I realized the top seal of niskin #6 was open. The line was raised back up and then dropped back to the appropriate depth before triggering.
Event 39	Due to high seas, dFe samples 246 and 247 were not taken until 8 hours after sampling. Since goflo #7 was leaky, dFe sample 248 was lost.
Event 50	Messenger was accidentally dropped while attaching to bottle #10; bottles were raised and redeployed before dropping the triggering messenger.
Event 50	Niskin #6 (150 m) failed to close. No samples were taken at 150 m.
Event 63 and 66	Goflo #7 was very leaky, possibly due to alignment of the RBR.
Event 66	Due to miscommunication with the winch operator, weights were only lowered 5 m below niskin #10 rather than 50 m.
Event 68	Niskin #6 failed to close and was immediately redeployed on its own in a second cast, triggered at 11:29AM.
Event 86	After collecting all samples, the capsule filter was accidentally dropped and the bottom air seal broke off. This did not appear to affect the function of the filter, so I continued to use it.

Additionally, I assisted with sampling of **dissolved inorganic carbon** (water collection from the rosette into 1L glass bottles and 'pickling' with mercuric chloride) at stations Haro-59, JF-2, P1, P2, P4, P12, and P25, and sampling of **alkalinity** ('pickling') at station P26. Data obtained from the first two stations may reflect my inexperience at collecting DIC samples.

2017-06 Cruise Report: pH and DIC/Alk – Glenn Cooper, DFO/IOS

1) Seawater pH analysis:

Seawater pH was determined using the spectrophotometric method developed by Clayton and Byrne (Deep Sea Research, 1993). Seawater was collected directly from the rosette niskins into 10cm path length glass cuvettes. Purified meta-cresol purple was used as the indicator dye and was validated prior to the cruise at Institute of Ocean Science (IOS). All work was performed in the temperature control lab on the John P. Tully.
The following major stations were sampled: P01, P02, P04, P12, P16, P20, and P26. One set of triplicate samples were taken at stations P01 and P02, whereas all other casts had two sets of triplicates. Replicates will be used to determine precision for the entire cruise. An inter and intra niskin calibration cast was performed at P25 where triplicates were taken from 5 niskins which were closed at all the same depth of 2005m.
Institute of Oceans Sciences (IOS) has transitioned into the use of purified m-cresol purple (m-CP) indicator dye obtained from the Byrne laboratory. There is evidence that dye obtained from some chemical manufactures may contain minute impurities which can absorb at the same wavelengths used in the determination of sea water pH. Before the availability of purified m-CP, IOS has been using a single stock from Anachemica (Lot#780322). In order to ascertain if there are impurities in the Anachemica stock, a comparison between Byrne's purified dye and the Anachemica dye were performed at stations P14, P18 and P26. At P14 water samples were collected at 500m, 400m 300m, 200m, 100m and 50 meters. For stations P18 and P 26 the following depths were collected: 500m, 300m, 200m, 150m, 100m and 50 meters. These depths represent the entire pH range of seawater typically seen on the Line P mission. All samples were collected in quadruplicates whereby two of the samples were analyzed with the purified dye and the remaining two samples with the Anachemica stock. Once final salinity values have been obtained from the post processing of the CTD data and/or final salinity bottle data, final pH values obtained from both dyes can be compared to ascertain if there are differences and if corrections to the old data sets need to be applied.

2) Dissolved Inorganic Carbon and Alkalinity sampling:

DIC/alkalinity samples were collected into 500ml glass bottles and preserved with 100ul of saturated $HgCl_2$ at the following stations: Haro59, JF02, P1, P2, P4, P12, P16, P20, P26. An inter and intra niskin calibration cast was performed at P25 where triplicates were taken from 5 niskins, all of which were closed at same depth of 2000m. Stoppers were greased with Apeizon grease and taped closed with electrical tape, placed into the 4^{o}C walk in cooler until unloaded at IOS for onshore analysis. At P26, a complete extra set of samples were collected for archiving; however, due to water constraints the bottom -10 meter sample was not taken.

We would like to thank all of those who assisted in the collection and preservation of the DIC/Alk samples. Your help was truly appreciated.

Brief Report for Experiments on Line P Cruise in June 2017 – Yuanheng Xiong
June 16th, 2017

Two major instruments are brought with me on Line P cruise: the ViewSizer 3000 (MANTA Inc., San Diego, CA) and the LISST-VSF sensor (Sequoia Scientific Inc., Bellevue, WA). The major goal is to test the performance of these instruments in field, so that the pros and cons of these new instruments will be known for future experiments. With these instruments, the particle size distribution (PSD) and the particle volume scattering function (VSF) of seawater are measured.

Sampling:

1. For all stations from JF2 to P26 (29 in total), the PSD and VSF were measured on-site with 4 liters of surface seawater collected from the rosette. 250 ml samples were collected at multiple depths (0 m, 10 m, 25 m, 50 m, 100 m and 300 m, when available) and stored at 4 °C for future lab experiments to measure the PSD under stabilized conditions.

2. For major stations (P2, P4, P8, P12, P16, P20 and P26), the PSD and VSF were measured with 4 liters of seawater at multiple depths (0 m, 10 m, 25 m, 50 m, and 100 m, and 300 m, when available). However, due to an instrument configuration issue at the beginning of the cruise, the depth profile at P2 only included 0 m and 10 m.
3. For stations P12, P20 and P26, 5 ml seawater at bottom-10 were available for the PSD measurements on-site and more than 150 ml seawater was stored for future lab experiments.
4. For all VSF measurements, the original seawater, 0.7 um filtered seawater and 0.2 um filtered seawater were measured separately, but the sensitivity of LISST-VSF is usually not enough for the filtered seawater.

Preliminary result shows the LISST-VSF is suitable for measuring particle VSF in field, and the ViewSizer will be suitable for measuring PSD in field with additional adjustment or under relatively calm surface conditions. VSF information will be available for entire Line P at surface and contain depth profile for major stations, PSD information might contain depth profile for entire Line P after the lab experiment.

This is my privilege to join the Line P cruise. I would like to thank the entire crew of the *Tully* for their assistance, patience, and kindness, with special thanks to Jimmy and Bruce, who specifically helped me with relocating and storing my heavy and large packages. I also want to thank the IOS team for arranging this cruise so well and the entire science team for helping me countless times on *Tully*, with special thanks to Mike, who helped me greatly for loading and setting up the entire gears, and Marie, who guided me from the first beginning and made extra effort to ensure my unique sampling wishes were realized. I couldn't do it without all of their help.

Line P – June 2017: Theresa Venello, UVIC (Dower Lab)

Objectives: Quantifying crustacean zooplankton productivity along Line P using the chitobiase-method. Comparing production rates from the *Tully's* seawater loop system and 5 m rosette niskin bottle. Linking zooplankton community composition to crustacean zooplankton productivity.

Sampling:
500mL of seawater was taken from 6 depths (5, 10, 20, 50, 150, 250 m) at all 7 major stations that have a bongo net cast (P2, P4, P8, P12, P16, P20, P26). Samples from all stations were taken on the way out to P26. Loop seawater samples (500 mL) were also taken at each of these stations.

In addition, loop seawater samples were taken at P6, P10, P14, P19, P22, P24 to increase the spatial resolution of our production rate estimates. All samples were collected on the way out to P26.

Water was taken from the rosette, filtered through 54µm mesh and into 500 mL Nalgene bottles. Water samples were then 'spiked' with a homogenate made from ground krill and/or copepods (depending on what was in the bongo sample); filtered every three hours over a 12 hr period to create a decay of the moulting enzyme chitobiase. Samples were assayed and read using a fluorometer while on board.

Zooplankton samples were also collected from the rosette at P2, P4 and P26 by filtering whole niskin bottles at three depths (5, 50, 100) through a 40 µm mesh sieve. The white ring net (60 µm) was also used at P2, P4, P8, P16, P20 and P26 to collect an additional zooplankton taxonomy sample. All samples were collected on the way out to P26, however, no white ring net sample was collected at P12 due to weather restrictions. The P12 ring net sample was also not conducted on the way back due to time limitations. This work was conducted for Evgeny Pakhomov and Lian Wong at UBC.

Comments:
All of our sampling goals for this cruise were met.

We'd like to thank the Captain and crew of the *Tully* for all their assistance and hard work throughout the cruise. Thanks to Marie Robert and the IOS science crew for having us on board to do this work and accommodating our sampling needs.

2017-06 Cruise Report – Amanda Timmerman – University of Victoria

Biological productivity is an important process controlling the export of carbon to the deep ocean. There are multiple methods to estimate production and I focused on two techniques: dissolved gas ratios and incubations. Dissolved gas ratios included measurements of oxygen, nitrogen and argon (ONAr) ratios and triple oxygen isotope ratios. Incubations included dual $^{13}C/^{15}N$ additions.

ONAr: Samples were collected in duplicate at two depths within the mixed layer at P4, P12, P16, P20 and P26. Duplicate samples were also taken three depths (0, 5 and 10 m) at PA-011 and PA-010 after the second deployment of the mooring and before the mooring recovery, respectively. ONAr samples collected on this cruise will be analyzed at the University of Washington to obtain precise measurements of O_2/Ar.

Dissolved oxygen: Duplicate samples were collected from the oxygen maximum and two depths within the mixed layer at P4, P12, P16, P20 and P26. Duplicate samples were also taken at PA-010 and PA-011 at 0, 5 and 10 m. Dissolved oxygen samples were analyzed on board using the Winkler titration method with a visual endpoint.

Triple oxygen isotope: Duplicate samples were collected within and below the mixed layer at P4, P12, P16, P20 and P26. The below the mixed layer depth was chosen based on the oxygen profile. Samples will be analyzed for the 16, 17 and 18 oxygen isotopes.

Dual tracer incubations, NH4, nutrients, chlorophyll: Samples were collected at 5 light depths (100, 55, 30, 10 and 1%) at P4, P12, P16, P20 and P26. Two sets of incubations were done using $NaH^{13}CO_3$ and either $^{15}NO_3$ or $^{15}NH_4$. Each set of samples was done in triplicate at 100% and single samples at all other depths. A blank and dark were collected at 100% light level for each ^{15}N nutrient. All incubations were incubated for 24 hours under a constant flow of seawater and then filtered. Duplicate NH_4 samples and single nutrient and chlorophyll samples were collected at the 5 light depths as well.

Salinity: Samples were collected below the mixed layer, within the oxygen maximum and at 50%, 30%, 15% and 1% light levels at P4, P12, P16, P20 and P26.

Phytoplankton: Samples were collected at a single depth in the surface water (5 m) at P12, P16 and P20. The following preservatives were used: lugol, formalin and glut.

Acknowledgements: Thank you to everyone for making my last Line P cruise as a PhD student successful. Thank you especially to Marie for her support and accommodating my sampling requests, Glenn and Theresa for helping with the incubator, IOS personnel for analyzing samples and Sarah Thornton for providing science equipment. I also want to thank Mark, Robert, Theresa and Conor their help sampling. Thank you to the Captain, officers and crew of the JP Tully.

Cruise Report. PMEL Station Papa Mooring, June 4-19, 2017 – Patrick Berk & Michael Craig.

This mission was to refresh the PMEL station PAPA surface mooring. The mooring is part of the network of OceanSITES time series reference stations and the center of a cluster of moorings and projects deployed at station PAPA at the end of line P.

The mooring is composed of a full suite of metrological sensors on 2 redundant data collection systems. Subsurface sensors are attached on an inductive wire to a depth of 300m sampling temperature, conductivity and pressure. 2 current meters are installed at 15.5m and 35.5m and 2 current profilers are installed 1m and 68m, facing downward and upward respectively. A MapCO2 system from PMELs CO2 lab is installed in the buoy along with a SAMI PH sensor and a fully loaded sbe 16 CTD. All sensors except the current profilers report real time data via satellite. See details below.

Mooring equipment was loaded onto the CCGS John P. Tully on June 4th, 2017. The mooring was successfully setup and tested over the following week at sea. Mooring deployment operations began at 12:30 local time June 13, 2017. The mooring was deployed off the starboard side of the ship using the ships crane and line was then payed out through the a-frame using the ships capstan. Below the buoy, 325m of jacketed inductive steel cable holding 19 subsurface sensors was deployed, followed by ~3600m of nylon rope. An acoustic release with a deep water temperature, conductivity and pressure sensor was deployed 50m above the 4220m bottom. The mooring was anchored by two stacks of steel train wheels totaling approximately 6800 lbs.

All systems were functioning 100% prior to deployment as well as after the buoy was deployed but before anchor drop. Unfortunately after dropping the anchor and allowing the buoy to settle into position, all

subsurface inductive sensors were offline. All attempts to restore the subsurface sensors via RF communications were unsuccessful. It was suspected that all sensors were still functioning and recording as they should be, but a failure in the inductive loop had occurred which would inhibit real time transmission of data for the next year. After conferring extensively with the Captain and Chief Scientist, it was decided that a buoy with real time subsurface data was a priority of the mission and that there was time available to recover and redeploy the buoy.

The freshly deployed buoy was recovered the following morning (June 14). The acoustic release was fired without much difficulty and the ships work boat was launched to connect the recovery line to the buoy. The buoy was brought on board by the Tully deck crew without incident. Instruments were removed as the wire was recovered and the nylon was then spooled onto the spooling winch for redeployment. The top 1150m of nylon rope had to be respooled after recovery to prepare for redeployment as it has a specific orientation.

Once on deck repairs began. The inductive loop is comprised of three main components, the main electronics, the inductive cable (0-325m), and the "top section" that connects the two. The cable (which was a few years old) and top section were the primary suspects so both were replaced for the second deployment. However once the new components were installed the inductive modem in the main electronics was still repeatedly unable to "capture" the inductive line and communicate with any instruments. After a few hours of unsuccessful trouble shooting the main electronics in the buoy were replaced as well and all systems returned to working as they should. The exact source of the failure is yet to be determined.

Redeployment commenced the same afternoon and went just as smoothly as the first one. Sensors were reinstalled as the new inductive line was payed out. Anchor was dropped at our desired location at 18:25 on June 15, 2017 local time. All sensors were reporting successfully on our flyby of the buoy except for one that was inadvertently programed with the wrong time and will start on June 24th.

Recovery of the Papa 010A mooring began the following morning. Once again the crew brought the buoy onboard in a safe and controlled manner with no damage being done to the buoy or any sensors. Fouling was minimal compared to previous years and we were easily able to stop off the buoy, disconnect it and secure it out of the way on the deck. All instruments were recovered in good working condition and all downloaded good data. 2 instruments on the inductive line shut down early due to low battery voltages.

CTD casts were done after deployment and before recovery for comparison and C02 calibration.

Many thanks to the captain and crew of the Tully who performed above and beyond for safe and successful operations. We thank everyone for their flexibility and understanding when our project hit a serious snag. Special thanks to Chief Scientist Marie Robert for graciously sacrificing some of her planned work to enable us to successfully repair our mooring. Also thank you to Amanda Timmerman from UVIC for handling all CTD water sampling on behalf of UW and PMEL.

Deployed Sensors:

SURFACE	**# of Sensors**		**Subsurface**	**(#) & Depths (m)**
Air Temperature, Relative Humidity	3		Sea Surface Temp & Conductivity	**(2)** – 1m
Wind	2		Temperature, Conductivity	**(13)** -10, 14, 20, 25, 30, 37, 45, 60, 80, 100, 120, 150, 200
Rain	2		Temperature, Pressure	**(3)** – 5, 175, 300
Shortwave Rad.	2		Current Meters	**(2)** - 15.5, 35.5
Longwave Rad.	2		Current Profilers	**(2)** - 1, 68
Barometer	2			
CO2	**Depth**			
PMEL MapCO2	Surface			
SAMI PH	1m			
SBE16 – CTD, optode, GTD, O2, Flourometer	1m