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: Sir Wilfrid Laurier

DATE: **FROM:** 18 February 2018 **TO:** 8 March 2018

SCIENCE CRUISE NUMBER: 2018-01 **SHIP'S PATROL NUMBER:** 17-10

CHIEF SCIENTIST[S]: Marie Robert

SCIENTIFIC PERSONNEL:

Female	Male
Sarah Bercovici (UW)	Michael Arychuk (IOS)
Danielle Caleb (IOS)	Mark Belton (IOS)
Marie Robert (IOS)	Kyle Simpson (IOS)
Jade Shiller (UBC)	Yuanheng (Eric) Xiong (UND)
Theresa Venello (UVic)	

AREAS OF OPERATION: North East Pacific, Line P, Station P, Juan de Fuca Strait, Haro Strait, Georgia Strait.

INTRODUCTION/PROGRAM BACKGROUND: Line P is a long standing program which surveys a 1400 km long section 3 times annually. Data has been collected along this line since 1956 and shows 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 15 "sponge-bob" drifters for IOS.

CRUISE DESCRIPTION: For the first time we went to Station P on the *CCGS Sir Wilfrid Laurier*. This led to a different cruise in many aspects. The rosette winch is quite high above the surface and there is no heave compensation system on board so the seas have to be quite calm to do a cast. The rosette has to be latched between every cast making the sampling a little tricky. Also because the well deck is so exposed to the waves the bongos have to be stored back in the container between stations which stretches the time spent on station. The main lab is quite small and storage was a bit of an issue. On the bright side, the Laurier is a very stable ship and spending two and a half days in a storm waiting for calmer weather was definitely not as bad as it could have been! Her faster pace was also very valuable to catch up on delays due to weather. Finally, the positive attitude of everyone on board, the efficiency and help from all departments made for a great experience.

DAYS ALLOCATED: 18 **DAYS OF OPERATION:** 17

DAYS LOST DUE TO WEATHER: About 18 hours going from P15 to P26. 2.5 days waiting to do P20. The order of stations also had to be modified because of the weather.

SAMPLING:

- The Line P survey was quite successful despite the weather. Station P21 got cancelled, as well as two 1200 m bongo casts (P16 and P26) and two ring nets (P16 and P20). We also sampled six of the Strait of Georgia stations.
- 15 "Sponge-Bob" type drifters were deployed in Haro & Juan de Fuca straits for IOS.
- Trace Metal samples were not collected on this cruise, and neither were pH samples.
- The samples collected include:
  1) Underway: **IOS**: Thermosalinograph (Temperature, Salinity, Fluorescence), pCO_2 – **UBC (Izett, not on board):** "PIGGY" (O_2, N_2, total gas tension)
  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 – **UBC (Shiller):** high-resolution bacterial DNA sequencing, number of cells per millilitre, single cell DNA analysis, virus analysis, viral counts – **UW (Bercovici):** GELS, dissolved organic carbon (DOC) (for D. Hansell, U. Miami) **– UVic (Venello):** secondary production, zooplankton, 'bugs' (for E. Pakhomov, UBC) **– U. North Dakota (Xiong):** optics: volume scattering function, particle size distribution
  4) **DFO-IOS and UVic (Belton, Simpson, Caleb, Venello):** Zooplankton using vertical net hauls (Bongo to 250 m and 1200 m, and single fine-mesh "Ring" net to 250 m).

RADIOISOTOPE USE:

No radioisotopes were used during this cruise. The Rad-van was not on board.

PROBLEMS [SCIENCE - DFO]:

Thermosalinograph (TSG): the remote temperature sensor was not working.
The TSG has no flow meter.
During the deep cast at P12 we lost contact with all auxiliary sensors (dissolved oxygen, fluorometer, altimeter, transmissometer) and the pumps on the CTD. We tested some cables but that did not solve the issue. We had to swap the CTD for the spare unit.
The bongo buckets were not identified with "flow-meter" or "non-flow-meter" side and they were both identical so either side ended up frozen/pickled.

SUCCESSES [SCIENCE - DFO]:

Thanks to Mike Dempsey, Sarah Zimmerman and Lucius Perreault for their help in setting up. Thanks to their help it only took a day to get ready to sail.
We managed to fit everyone in the lab (although pH sampling had to be sacrificed).

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

There was a problem with the bongo winch sheave at beginning of cruise; it was ceased up. We had to wait a couple of hours before getting on our way to be sure it could be fixed on board.
There was a problem with the CTD block at station P13. The cast got aborted at 150 m and was restarted almost two hours later.
The 12 kHz sounder is not very reliable, especially in deep water.
The lack of a heave compensation system prevents work in non-perfect conditions.

We could not collect pH or Trace Metal samples.
There is no cold room on board to preserve some of our samples. Since the heaters were often "on" in the helicopter hanger, which we used as a "cold room", some of our samples might be compromised.
There were lots of paint chips in the bongos, and even a barnacle in one sample.

SUCCESSES [SHIP]:

For the second year in row this cruise showed the importance of getting the extra four days for the February cruise. We had to modify the order of stations as well as cancelling 15 stations because of bad weather on our way west and we lost almost three days due to bad weather waiting to do station P20 on the way back east. Because the Laurier is quite faster than the Tully we were still able to sample a few stations in the Strait of Georgia despite having used the extra days as "weather days" during the Line P portion of the cruise.
The Laurier is also a very stable vessel. It would have been a lot harder waiting through the "P20 storm" during all that time on a smaller vessel.
It was wonderful to have the extra personnel on board. The science party was rather thin on this cruise so the extra hands were much appreciated!
The Chief Scientist email account was very valuable for the days that we were out of internet range, as well as for 'daily businesses'.
The internet signal reached much further west than expected.
The FRC was used to meet someone from IOS in Sidney on March 6 to pick up more DIC sampling bottles since we didn't have enough on board. This allowed us to complete our program in the Strait of Georgia.

DELAYS [OTHER THAN WEATHER]:

~1 hour at the beginning of the cruise to wait for the winches spare parts box.
~2.5 hours at the beginning of the cruise to try fixing the bongo winch sheave.
~3 hours because of CTD issues at P12.
~2 hours to fix the CTD winch block at P13.

SAFETY CONCERNS:

It can be tricky to bring frozen samples from the main lab to the freezers located in the hold.

HAZARDOUS OCCURRENCES:

A cold was being propagated on board the ship during the cruise, affecting many crew members and some of the science staff.

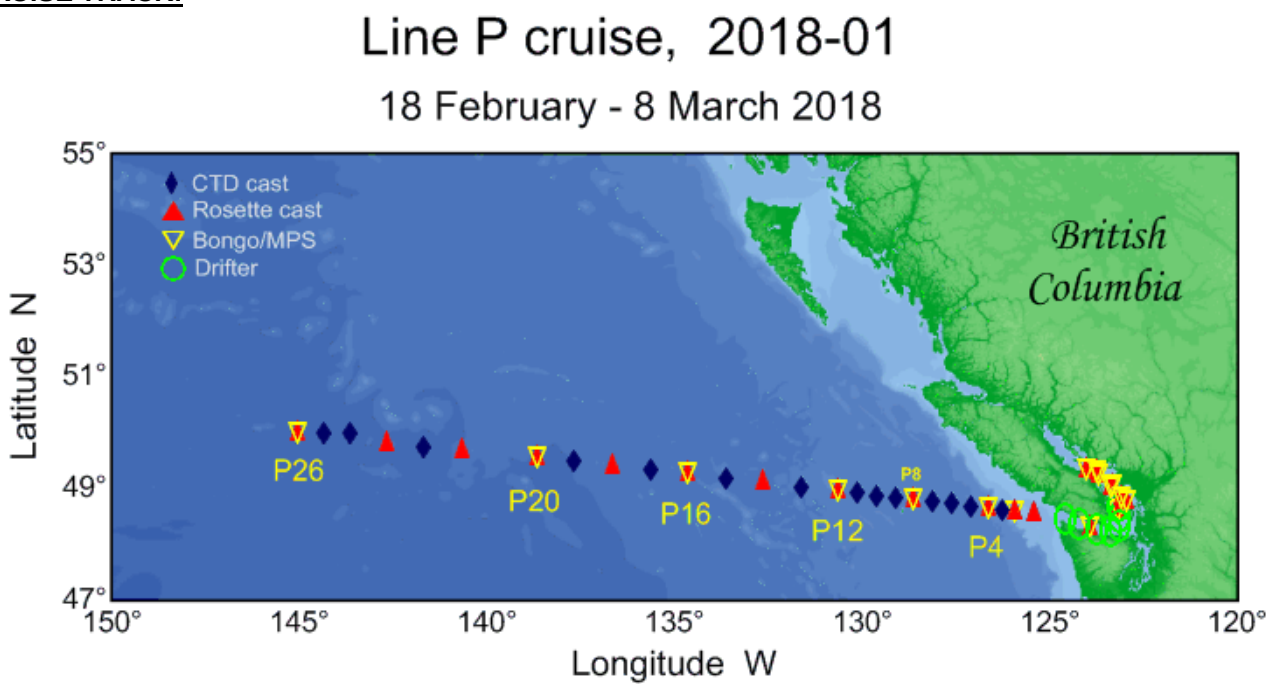
EVENT LOG:

Sunday 18 February:	Start loading scientific equipment around 1000.
Monday 19 February:	LB crane at 0800. Keep loading science gear. Leave the dock ~1500. Safety meeting 1600. Test cast in Saanich Inlet ~1700. Underway around 2130, go straight to P1.
Tuesday 20 February:	Stations P1 to P4. Fire and boat drill at 1300.
Wed 21 February:	Stations P5 to P8. Cancel stations P9 and P10.
Thursday 22 February:	Cancel Station P11. Do station P12, start P13.
Friday 23 February:	Stations P13, P14, P15. Cancel P16 and P17. Sail west.
Saturday 24 February:	Weather day. Cancel P18 to P21. Sail west.
Sunday 25 February:	Weather day. Cancel P22 to P24. Sail west.
Monday 26 February:	Sail by P25 and P35. Arrive at Papa at 0600. Do all the Papa work from 0800 to 1730, then PA-011 and P35.
Tuesday 27 February:	Stations P25 to P22.
Wed 28 February:	Cancel Station P21. Go wait at P20. Weather day.
Thursday 1 March:	Weather day.
Friday 2 March:	Weather day. Science "show & tell". Start P20 at 1600.
Saturday 3 March:	Stations P19 to P16.
Sunday 4 March:	Stations P11 and P10.
Monday 5 March:	Stations P9 and JF2.
Tuesday 6 March:	Stations Haro59, 56, 46, 42, 41, GE01, CPF1.
Wednesday 7 March:	Back to IOS. Offload science gear.
Thursday 8 March:	LB crane at 0900 to offload CTD winch and DMS container.

OTHER:

There was some confusion at the beginning of the cruise as to whether everyone on board had proper security clearance to sail. This issue has to be resolved since it keeps coming back from cruise to cruise. The Chief Scientists (CS) is expected to provide participants' date of birth (DOB) to the security officer (SO), but we (CS) do NOT possess this information. When the participants are asked to contact the SO to provide their DOB they are asked to NOT get in contact with the SO!

CRUISE TRACK:



SUMMARY/FINAL COMMENTS:

- This cruise would not have been possible without the help of the "regulars on the Laurier": Jane Eert, Mike Dempsey, Lucius Perreault and Sarah Zimmerman. Thank you all so much for your time and knowledge, especially for those who showed up on the Sunday. Thank you for the loan of the "GPS pucks".

  Many thanks to everyone at IOS who have helped to get this cruise ready and will deal with the samples and data after: Kelly, Kenny, Nina, Moira, Tamara, Scott, Hugh, Germaine … your help is always greatly appreciated!

  Thanks to the "Arctic group" and particularly to Humfrey Melling, Svein Vagle and Jo Poole for the use of the "Green container" and the TSG.

  Thanks to everyone on board for such a successful cruise despite the February weather! Some I met and chatted with, some worked more 'behind the scene', but everyone was part of the success of the cruise in his/her own way. Thank you!

  Finally, some special "thank you":

  - To Ian for making the pre-cruise preparations went smoothly
  - To Tom for the delivery of the daily weather forecasts
  - To Captain Dockerill for the reading of those forecasts
  - To Nate for your unstoppable enthusiasm and Lyndsey for your great questions
  - To Shane for your help setting up at the beginning and for the black magic on my laptop so I could see the ship's network

- To bosun Kurt for all the great help on deck and solving all kinds of little problems with great efficiency
- To Chief Randy for the morning smoothies
- To Laurie for the popcorn on movie nights
- To Justine for the great daily quotes and menu photos
- To the galley crew for feeding us so well
- And again, to every one of the Laurier crew; not ALL Line P cruise are this rough! ☺

See you all in May for the La Perouse cruise I hope! ☺

Marie Robert

- This is my privilege to join the February 2018 Line P cruise. I would like to thank the entire crew of the *Laurier* for their assistance, patience, and kindness, with special thanks to Kurt, who specifically helped with deploying the LISST-VSF. They work hard to help us all the way. I also appreciate the IOS team for arranging this cruise nicely and the entire science team for their great help during the cruise.

Yuanheng Xiong

- I'd like to thank the captain and White Crew of the *Sir Wilfrid Laurier* for their assistance, excellent work, genuine interest in our scientific work, and eagerness to ensure that the time series continues uninterrupted. Thank you to the cooks, Harold and Herb, for keeping us so well fed and excited for the next meal. Thanks to the IOS team and my fellow scientists for their help and their humour on deck and in the lab. And finally, a great big thank-you to Marie for working so hard to make Line P happen as smoothly on the *Laurier* as it always happens on the *Tully*.

Jade Shiller

- We are very grateful to Marie Robert, Jade Shiller, Theresa Venello, and all of the scientists on this cruise for enabling us to continue our testing of the optode/GTD system in an unmanned capacity, and for collecting our discrete gas samples. We thank Jade for her willingness to oversee our gas sampling, and to monitor the optode/GTD in case of any minor malfunctions. Our deployment was successful, with no instrument and/or technical issues. As always, we are very grateful to Marie for accommodating our research objectives, particularly in light of the additional challenges posed by the temporary use of the *Laurier*.

Robert Izett

- We'd like to thank the Captain and crew of the *Laurier* 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 the crew of the *C.C.G.S. Laurier* for their support on board and thank you to the science party for their support and help with sample collection.

Sarah Bercovici

PROJECTS AND RESULTS:

Water masses – Marie Robert, DFO/IOS.

The weather during this cruise has been quite stormy. We managed to do the most of the Line P work except for Station P21. In order to achieve this we had to wait for good weather for almost 60 hours at Station P20. Figure 1 shows our weather course during that time. Because of these storms the mixed later depth was quite deep, ~90 m; a 'normal' value for February. Finally it seems that there is some rather salty water at depth near the coast. This is in contrast with the last two February cruises where the surface coastal waters were saltier. Figure 2 shows the salinity anomaly field with respect to the 1956-1991 averages in February 2016, 2017 and 2018, from the surface to 500 dbar.

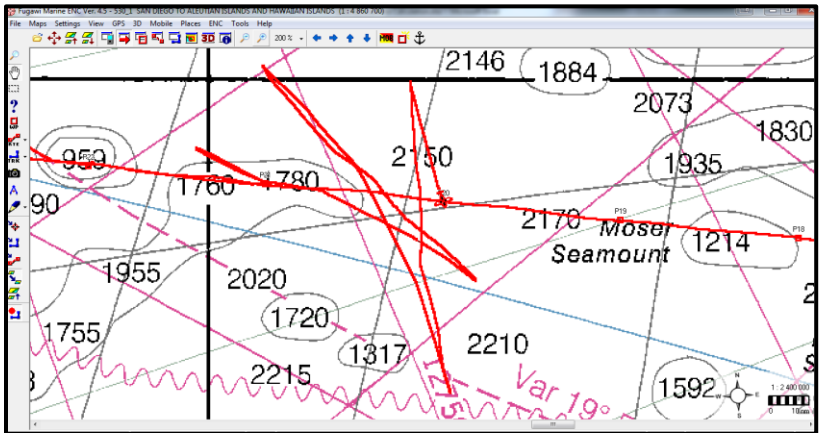


Figure 1: Ship track during 2018-01 Papa cruise, from early on 28 February to ~1600 on 3 March 2018.

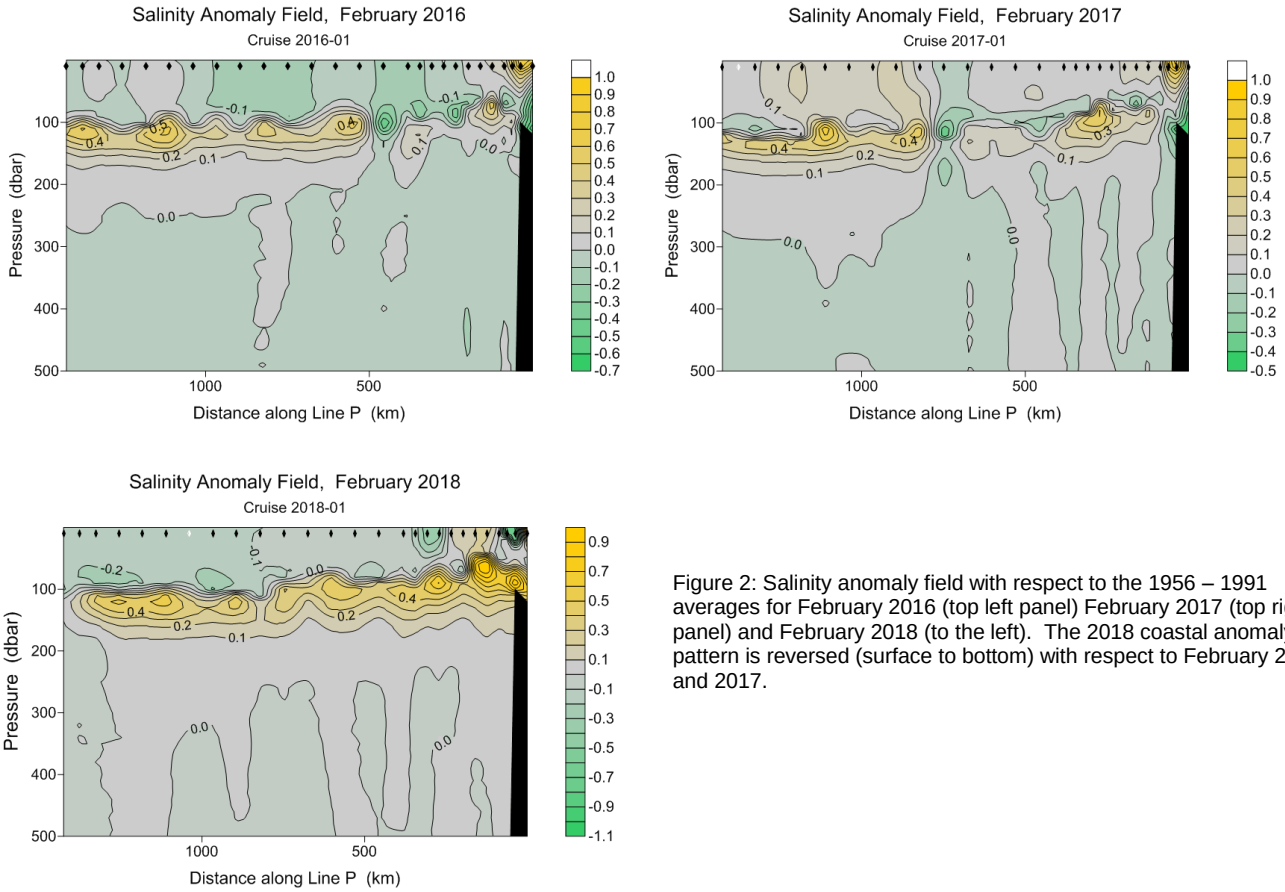


Figure 2: Salinity anomaly field with respect to the 1956 – 1991 averages for February 2016 (top left panel) February 2017 (top right panel) and February 2018 (to the left). The 2018 coastal anomaly pattern is reversed (surface to bottom) with respect to February 2016 and 2017.

PCO2 – Michael Arychuk, DFO/IOS.

The underway PCO_2 system worked well this cruise despite it being configured to work aboard the Tully and not the Laurier. The first challenge was getting the GPS feed for the instrument. With the help of Sarah Zimmerman and Kyle Simpson the instrument data string was configured for the Laurier network and made available for the PCO_2 software. Unfortunately, for some reason, shortly after the PCO_2 was started the GPS feed to the instrument froze and was not noticed for four days. There was no explanation for the "freeze" and after a re-start of the system the GPS feed never froze again. The missing GPS data can be cross referenced from the TSG file so the data collected on the first few days is still valid. The second problem was that there was no access to the outside air from the main lab. On the Tully there are several pass throughs in the lab but those do not exist on the Laurier. The atmospheric line was initially pulling the air directly from the lab but this biased the values high and was very unstable due to the amount of people working in the lab. The only option was to put the atmospheric line out a window but all the windows in the lab were sealed or stuck. Thankfully with the help of the ship's crew one of the windows was forced open on day 2 and a line was able to be put outside. The final problem was that with the atmospheric line pulling air from the outside window there was also a tendency for the line to also pull water when the weather (rain) was particularly bad. Thankfully there is a "trap" that cleans the air before it goes into the instrument for analysis and the water did not get into the valves or detector. These are all things to keep in mind for future cruises where the PCO_2 system is required to be put on a ship other than the Tully.

Brief Report for Line P Cruise in February 2018 – Yuanheng Xiong, University of North Dakota

The volume scattering functions (VSF) of seawater were measured onboard by the LISST-VSF (Sequoia Scientific Inc., Bellevue, WA). The particle size distribution (PSD) will be measured in lab by the ViewSizer 3000 (MANTA Inc., San Diego, CA) using seawater samples collected simultaneously during this cruise. Additionally, a few attempts of measuring the VSF depth profiling in water (0 – 50 m) were performed. VSF and PSD data will be available for entire all stations at surface and at several depths for major stations. The data collected during this February cruise will be compared with the data collected in June 2017, and the variations will be analyzed.

Sampling:

1. For all stations, excluding the stations skipped due to weather, the VSFs were measured on-site with 4 liters of surface (5 m) seawater collected from the rosette. 250 ml samples were collected and stored at the cool room for future PSD measurements in lab.
2. For major stations, the VSFs were measured with 4 liters of seawater at multiple depths (surface, 10 m, 25 m, 50 m, and 100 m, 300 m, and bottom -10 m when available). The continuous depth profiling (0 – 50 m) of VSFs was performed at P26 and P16.
3. For all VSF measurements, the original seawater and 0.7 um filtered seawater were measured separately. Seawater collected from bottom -10 m was also filtered by 0.2 um filter for the background measurement of the LISST-VSF.

This is my privilege to join the February 2018 Line P cruise. I would like to thank the entire crew of the *Laurier* for their assistance, patience, and kindness, with special thanks to Kurt, who specifically helped with deploying the LISST-VSF. They work hard to help us all the way. I also appreciate the IOS team for arranging this cruise nicely and the entire science team for their great help during the cruise.

Hallam lab, UBC (Jade Shiller) – February 2018 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.

On behalf of the Tortell lab, I also collected samples to quantify the distribution of biogenic gases in surface and subsurface waters along the Line P transect. Automated instruments for underway analysis were also used to study dissolved gases (oxygen and nitrogen [O_2 and N_2, respectively]) and gain insight into net community production (NCP) and discrete depth profiles and surface samples were collected for subsequent laboratory analysis for nitrous oxide (N_2O) and methane (CH_4) concentrations.

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.

Discrete gas measurements:
At the major stations (P4, P8, P12, P16, P20, and P26) we collected discrete profile samples for analysis of methane (CH_4) and nitrous oxide (N_2O), contributing to the Tortell lab's decade-long time-series of these gases along the Line P transect. Surface (5 m Niskin) samples were collected for analysis at every even-numbered station.

Underway measurements:
We also continued our deployment of the Optode/Gas Tension Device (GTD) setup ("Miss Piggy") in the lab with the ship's seawater flow-through system. Using these instruments, we derive underway O_2/N_2 data, which can also be used to quantify net community production (NCP). We have been developing and testing this instrument setup since February 2016, with the goal of replacing our aging and costly membrane inlet mass spectrometry (MIMS) system. The new platform is also capable of long-term, autonomous data collection, without the need for human interface. This cruise represented the first successful "unmanned" deployment, with no direct participation from Tortell lab personnel.

Comments:
All of my sampling objectives for this cruise were successfully fulfilled. In spite of the limited lab space, I was able to comfortably set up my equipment and collect all of the microbial and viral samples.

Due to weather and time constraints, we were not able to sample P4 on our return to shore. All other gases samples were successfully collected.

I'd like to thank the captain and White Crew of the *Sir Wilfrid Laurier* for their assistance, excellent work, genuine interest in our scientific work, and eagerness to ensure that the time series continues uninterrupted. Thank you to the cooks, Harold and Herb, for keeping us so well fed and excited for the next meal. Thanks to the IOS team and my fellow scientists for their help and their humour on deck and in the lab. And finally, a great big thank-you to Marie for working so hard to make Line P happen as smoothly on the *Laurier* as it always happens on the *Tully*.

Comments from Robert Izett (Tortell Lab):
We are very grateful to Marie Robert, Jade Shiller, Theresa Venello, and all of the scientists on this cruise for enabling us to continue our testing of the optode/GTD system in an unmanned capacity, and for collecting our discrete gas samples. We thank Jade for her willingness to oversee our gas sampling, and to monitor the optode/GTD in case of any minor malfunctions. Our deployment was successful, with no instrument and/or technical issues. As always, we are very grateful to Marie for accommodating our research objectives, particularly in light of the additional challenges posed by the temporary use of the *Laurier*.

Line P – February 2018: Theresa Venello-UVIC (Dower Lab)

Objectives: Quantifying crustacean zooplankton productivity along Line P using the chitobiase-method. 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 station P2, P4, P8, P12 and P26 were taken on the way out to OSP, with P20 and P16 taken on the way back in.

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 and P26 by filtering whole niskin bottles at three depths (5, 50, 100) through a 40 µm mesh sieve. The ring net (60 µm) was also used at P2, P4, P8, P12, and P26 to collect an additional zooplankton taxonomy sample. Net tows were collected on the way out to OSP. 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 *Laurier* 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.

Dissolved organic carbon (DOC) and marine microgel sampling – Sarah Bercovici, UW.

Objective:
DOC and marine microgel samples were collected from the CTD rosette at even stations (2 through 26, except for 6 and 10) along Line P. These samples are being collected to understand the seasonal and spatial dynamics of DOC and gels along this transect.

Methods:
DOC samples:
Samples were rinsed three times and subsequently collected into 40 ml combusted glass vials. At depth (>400 m), samples were collected directly into the glass vials. Above 400 m, samples were filtered in-line using acid-cleaned polycarbonate filter holders housing a 47 mm combusted 0.7 µm GF/F filter. Immediately upon collection, samples were acidified with 100 µl of 10% HCl and stored in the lab until shipment and analysis at the University of Miami. At station 22, two DOC profiles were collected: one entirely unfiltered (samples collected directly from the Niskin), and one entirely filtered with the GF/F filter.

Marine microgels:
Samples were rinsed three times and subsequently collected into 125 ml brown HDPE bottles. Afterwards in the lab, 500 µl of a 3% sodium azide solution were added to each sample bottle (for a final concentration of 0.01% of sodium azide). Samples were refrigerated until analysis in the lab.

Observations / issues while sampling:
Station 20: The CTD rosette was slick with oil from the wire. It was getting everywhere in large clumps, including the valves on the Niskin bottles, which may compromise the sample. It also got people's gloves, which touched the Niskin spigots. This would have an effect on DOC concentrations and potentially the gel abundance. The oil could have also been present at other stations (but station 20 was remarkable).

Comments:
Thank you to the crew of the *C.C.G.S. Laurier* for their support on board and thank you to the science party for their support and help with sample collection.