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:** 30 April 2023 **TO:** 16 May 2023

SCIENCE CRUISE NUMBER: 2023-066 **SHIP'S PATROL NUMBER:** 23-02

CHIEF SCIENTIST[S]: Marie Robert

SCIENTIFIC PERSONNEL:

Female	Male
Danielle Caleb (IOS)	Michael Arychuk (IOS)
Rowena Diggle (UBC)	Mark Belton (IOS)
Julia Fast (UBC)	Kavi Maruti Heerah (MUN)
Moira Galbraith (IOS)	Jody Klymak (UVic)
Lu Guan (IOS)	Alastair Roberts (UBC)
Grace Ho (UBC)	Bernard Yang (UVic)
Olivia Melville (UVic)	
Marie Robert (IOS)	
Stephanie Walsh (CNL)	

AREAS OF OPERATION: Saanich Inlet, Haro Strait, Juan de Fuca Strait, Line P, Station Papa, Queen Charlotte Strait, Strait of Georgia.

INTRODUCTION/PROGRAMS BACKGROUND:

Line P is a long standing monitoring 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 so far offshore 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, zooplankton, and trace metal sampling along Line P; Repeat Cesium survey along Line P; MVP survey for UVic/IOS; deploy floats for IOS and ONC; hydrography and zooplankton survey in St of Georgia for IOS.

CRUISE DESCRIPTION: This cruise was not secure until the last minute. Many changes in personnel were done during the weekend just before we left, up to the morning of our departure. Unfortunately one student didn't receive her security clearance on time to join us. The cruise pretty much kept going as it started: filled with gremlins. We were plagued with many data issues with the CTD, and some winch/crane issues as well. But we managed to sail and collect some data and we can all be happy and proud of this.

DAYS ALLOCATED: 16

DAYS OF OPERATION: 15

DAYS LOST DUE TO WEATHER: ~5 hours on our way from Station P to the Scott Islands.

SAMPLING:

- The cruise was very successful. All stations got sampled in order, every planned cast was performed. Only one CTD cast at P15 stopped at 375 dbar instead of 2005 because of CTD communications issues.
- Some extra work was also added: we did six casts in Queen Charlotte strait and sound, and sampled 25 major stations of the Strait of Georgia program for Kelly Young and Sébastien Donnet, since the SofG cruise was cancelled just before Line P.
- The samples collected include:

  1) Underway: Thermosalinograph (Temperature, Conductivity, Fluorescence), acoustic sounder, ADCP, MVP (Moving Vessel Profiler), pCO_2, met data (temp, winds, pressure, humidity), aerosol sampling.

  2) "E-data" from CTD: Pressure, Temperature, Conductivity, Dissolved Oxygen, Transmissivity x2, Irradiance, Fluorescence.

  3) From the Rosette: **IOS:** Dissolved oxygen, salinity, nutrients, chlorophyll, pigments (HPLC), DMS, DMSP, dissolved inorganic carbon (DIC), alkalinity, phytoplankton, biotoxins, domoic acid, chitobiase **– MUN (Heerah):** total organic carbon (TOC), dissolved organic carbon (DOC), coloured dissolved organic matter (CDOM) **– UVic (Guan for Hamme):** ONAr (Oxygen/Nitrogen/Argon ratio) **– UVic (Melville):** chlorophyll, particulate carbon and nitrogen, carbon gels, nutrients, particulate/biogenic silica, rhizaria silicon uptake using Si32 **– Canadian Nuclear Lab (Walsh):** cesium, tritium, iodine, stable isotopes **– UBC/Max Planck Institute for Marine Microbiology (Ho):** RNA, bacterial single cell amplified genomes, particulate organic matter, microscopy/bacterial cell counts, selfish uptake of polysaccharides by bacteria.

  4) Zooplankton nets: Vertical net hauls using a Bongo, 236 µm mesh size, were done to either 10 m off the bottom, 250 m, or 1200 m **– UBC (Roberts):** sampled crustacean zooplankton for viruses **– UBC (Fast):** sampled zooplankton for fatty acids.

  5) Trace metal Go-flos: **IOS (Caleb):** trace metals filtered, trace metals unfiltered, ligands, nutrients, salinity **– UBC (Diggle):** trace metals filtered **– U. Sherbrooke (Caleb for Guéguin):** Ligands.

RADIOISOTOPE USE:

Radioisotopes (32-Si) were used during the cruise. The Rad-Van was decommissioned at the end of the cruise.

PROBLEMS [SCIENTIFIC GEAR AND OPERATIONS]:

Despite having been booked well in advance, the cube van was locked and full of gear on loading day. We had to do all the loading via multiple trips with pick-up trucks.

A new Seabird TSG and remote temperature sensor were installed at the beginning of the cruise, but neither had been configured to output data. The factory default baud rate had to be changed to communicate with the TSG data logger. Many thanks to Lindsay Mazzei for fixing this issue just before we left the dock.

Once again the CTD Fluorometer had to be swapped for the spare one fairly early in the cruise, after station P12. As mentioned in the August 2022 cruise report, fluorescence issues seem to be more and more frequent. The source of the issues should be investigated.

At station P11 we started to see many spikes in the CTD data. All the CTD and sensors connectors were cleaned and re-seated properly but the spikes did not go away. After station P14 we decided to reterminate the sea-cable. Approximately 50 m of cable were cut off. During the cast following the retermination, at P15, we lost communication with the rosette at 375 dbar on the downcast. So the termination was performed again. Since this did not solve the issue, after P17 we

swapped the CTD (1515), which was a brand new one never used, for the spare CTD (0550). Unfortunately this still did not solve the issue. The spikes didn't show up on the screen during the casts anymore but they were still in the data. The sea cable got reterminated a third time on our way back from Station P. The spikes issue seems to be resolved; this said, we didn't have any more deep casts to do which would have confirmed that the issue was gone.

There were no good retermination instructions on board. There is a video available, but it is only available from the Water Properties website. Considering the cost and poor quality of internet access at sea, there should be a copy of that video on many sea-going computers. Actually, there should be a local copy of the entire Water Properties website on the Science Server, which could be updated at the beginning and end of the sailing season to reflect changes.

While looking at the data from Station P12 to investigate the spikes it was noticed that the configuration file for the new CTD (1515) was setup so that the deck unit was averaging 24 lines of data, instead of our regular 1 line of data. So all the casts from Saanich Inlet to P12 inclusively contain only 1/24 of the usual data.

I spent a lot of time being the liaison between people on board the ship and people at IOS for problem solving and troubleshooting issues. I think that everyone going to sea should have a DFO cell phone. MSTeams is extremely handy to have out here for texts or even calls (Teams calls). Maybe it would be possible to have one cell phone per ship or per program with which people could log in using their own profile as needed, as with a laptop; if not, sea-going personnel really should have their own DFO cell phone.

Unfortunately we did not get to test or use Mark's e-logbook during this cruise. By the time we were done with troubleshooting the issues that the UHF radios were causing to the communications with the CTD we were too far in the cruise to catch up using the e-logbook.

pCO_2 report – Michael Arychuk

The pCO_2 system was taken out on this cruise and did not perform up to expectations. Approximately three years ago the laptop that ran the system suffered a HD failure and the subsequent reinstallation of the software on a new laptop resulted in many incompatibility issues with the newer Windows operating system and the pCO_2 code. The contractor who wrote the original code was contacted and asked if he could try and get the code working again but the compatibility issues between the third party software, the code as well as Windows were numerous. Furthermore, the contractor had since changed jobs and was not very motivated to help solve the problems. Nevertheless, he did piece together a code that was somewhat operational minus a lot of the visual interface and statistical checks. The system was tested in the lab and gave relatively good data while running just standards but to fully determine the value of the data from the system it was required to test the system at sea. This cruise was the first opportunity to test the system and immediately problems were discovered. Mostly the issue was related to the code no longer being able to pull in the GPS data. I did contact Kyle Simpson about this but it was very difficult to try and troubleshoot the problem while at sea. I personally spent over 12 hours going through multiple versions of the code on the laptop and did find one version where the GPS data was being captured but, unfortunately, on that version specific hardware on the pCO_2 system were disabled. Basically, there were two copies of a working code that were only half working. Both copies were sent to Kyle Simpson to be forwarded to the contractor for guidance. That was approximately three days into the cruise. No further communication or guidance from the contractor was ever received.

While waiting for some information from the contractor I did continue to run the system without any GPS data only to discover that additional problems would also need correcting before the system could be brought out again. Specifically, the code no longer gave correct RTD temperature readings, flow meter readings, and specific statistical data that helped validate the data instantaneously. Furthermore, certain alarms that were also written into the original code to prevent flooding and component failure were non-functional in the new code which made one very uneasy about leaving the system unattended. Finally, the system also froze un-expectantly or lost communication with the LiCOR several times throughout the cruise.

The bottom line is that this system is not fit to come out to sea. The code needs to be re-written or a new system needs to be explored. I do feel the hardware is still functional and has the ability to generate good data (and because I designed it I can troubleshoot it effectively) but without a functional code it is a waste of resources, gases and an analyst's time.

There is constant conversation about the value of pCO_2 to the Line P program yet no one appears to want to take charge of the project full time, look at the data consistently or offer guidance. There needs to be conversations at higher levels about how to move forward, and funding provided to find solutions. I would be willing to help get a new system, get the code re-written for the current system and even help maintain and train someone to run the system but I am no longer willing to put any additional time and effort into the project or the instrument as it currently stands. I see no point in pursuing the pCO_2 project along Line P and I will no longer bring out the system in its current state.

DMS report – Michael Arychuk

The new DMS system was brought out on this cruise for field testing. It was run alongside the old system for three of the stations to evaluate the reproducibility and precision parameters. Based on the work done on this cruise there needs to be additional optimization of the new system back in the lab. The new system does give acceptable data but the precision is not as good as with the old system and some investigative work will need to be undertaken to find the problem.

The old system gave very good data this cruise but was plagued with minor software and communication issues from the beginning between the software (laptop) and the gas chromatograph (GC). At P26 the problem changed from a minor nuisance to a major problem when software completely stopped connecting with the GC and despite numerous re-boots of the GC and laptop, communication could not be restored consistently. In order to capture the DMS data for P26 the new system was used with all samples being run in duplicate. It might be important to note that an email was attempted to Agilent about the issue early in the cruise but because this cruise was plagued with internet issues the email could never be sent.

Issues and recommendations – Jody Klymak

- Still some confusion about acoustic setups. 1000 ms is not achievable by any of the sounders. On the other hand, the EK80 should not need to ping at 7 to 10 seconds. I'm also not clear why the CTD folks use the EK80 for bottom depth instead of the 12 kHz EK600 – by setting the EK80 to cover the whole water depth the ping rate is degraded, whereas if the EK600 were used the EK80 could ping faster.
- It would be preferable if the TSG were not running on the same computer as the ADCP. It seems the server would be fine for running this?

SUCCESSES [SCIENTIFIC]:

We made it. Despite all the setbacks and changes and uncertainties in the week preceding the cruise, we managed to load and sail according to the original schedule.

The new program written by Lindsay Mazzei to record GPS, TSG, and MET data seems to be working well. The only issue is that it is running on the ADCP computer so all that we can look at in real time are the flow meters. We should see if there's a way to have a display just for the TSG data near the loop sink.

It is good, and important, to be able to contact someone at DFO IT when we have login issues while at sea, without having to go through websites and tickets. Many thanks to Michael Jensen, Saul Bartoli and Céleste Grodesky for their help unlocking Moira's account.

Oxygen kit – Moira Galbraith

The Oxygen Kit #2 worked without any hiccups. There were problems noted with the Na/NaOH dispenser, mainly stickiness and some bubbling – just something to be aware of when using. The oxygen thermometers worked well and no bubbles were being trapped in the tubing.

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

As we were trying to get power to the trace metal container at the beginning of the cruise it was found that all the plugs on the outside aft bulkhead had been modified. When such changes are made it would be good practice to purchase the matching plugs so that "the clients" can still plug in their equipment in case they were not made aware of the change, as was the case here. Fortunately our departure was delayed on Monday morning and a nearby store happened to have the appropriate plug in stock.

The main Hawboldt winch wasn't paying in or out once loaded on the Tully, and again the following morning. Many thanks to Sean Eyding for coming to the ship on a Sunday afternoon to work on the winch.

The VHF radio was removed from the CTD closet and a new UHF radio was installed instead. Unfortunately this was done without consultation with science first. The UHF radios have been used on the Vector and we know that they interfere with our instruments. We switched back to using VHF radios but had to use the hand held ones in the CTD closet for the remainder of the cruise, which is not as practical. Also without a heads-up there were not enough UHF hand held radios on board. Each of our three containers must have a radio so the users can contact the bridge in case of emergency and there

needs to be a radio in Cabin A as well. We will purchase some UHF radios prior to the August cruise but hopefully we can just keep using the VHF radios during science programs. If would be great if the main VHF radio could be reinstalled in the CTD closet.

The LARS lost power a few times during the cruise, and so did the hydro winch. No exact cause was discovered.

The LARS head started to leak hydraulic oil towards the end of the cruise. Investigations lead to suspect that the brake was leaking.

The TullyCS email account would not send emails to anyone with a 'dfo-mpo.gc.ca' email address, unless by doing a reply to a previous message.

The internet connection was very poor during this cruise, especially once we were past P20. The "ONC dome" had a few issues due to a variety of factors. We have been saying this for many years but here it is again: in this day and age, a good internet connection should be an integral part of any sea-going vessel, just as food and toilet paper are. Having a good internet connection is not a luxury anymore, it is a necessity. A Line P cruise used to be four weeks long. We had time to troubleshoot things, make phone calls from the bridge, and try this and that. Now we barely have two weeks to cover the same distance and do the same *and* additional work, with instruments that increasingly require internet connection to troubleshoot.

SUCCESSES [SHIP]:

Once we were past ~P22 we lost all internet connection on all systems. Fortunately the "ship satellite system" got fixed which allowed us to then fix the ONC dome. Thanks to Albert Ruskey at ONC for all his help troubleshooting the ONC dome.

A storm delayed our return trip from Station P to the Scott Islands. Thanks to Captain Hamilton for using both engines so that we could catch the right tide at Seymour Narrows and have enough time to do the work planned in the Strait of Georgia.

After many cruises of giving us grief, the Trace Metal winch was spooling properly without needing "the drill".

Bongos – Moira Galbraith

The bongo deployment and retrieval at all net stations were trouble free. The winch counter, winch and bongo equipment were all working within expected parameters. On Line P, 16 casts were done, six of which were 1200 m deep. Thanks to the crew for maintaining wire angles and putting up with long wire times, this is much appreciated.

DELAYS [OTHER THAN WEATHER]:

A few hours at the beginning of the cruise for exchange of science personal, while the main Hawboldt winch was being repaired.
A few hours for tank breaks.

SAFETY CONCERNS:

The eye wash station on faucet of starboard aft sink in the main lab was found to be ineffective.
The eye wash bottle on the bulkhead above the sink in the main lab was found to be extremely difficult to squeeze and dispense eyewash due to old plastic.
There was no copy of the Worksafe BC's Laboratory Health and Safety Handbook nor of the DFO Laboratory Safety Manual 5790 brought by the DFO staff.

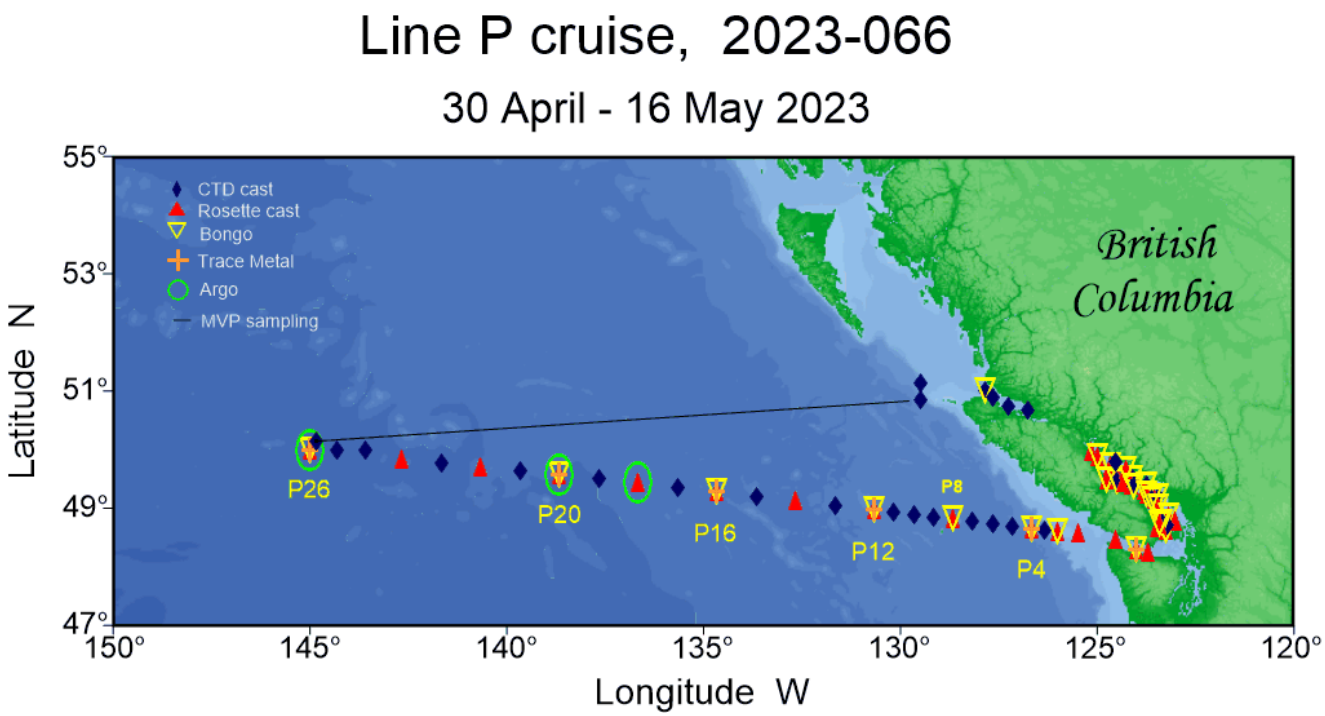
HAZARDOUS OCCURRENCES:

One science crew member received a drop of seawater containing diluted chemical solutions in her eye.

EVENT LOG:

Saturday 29 April:	Containers get loaded. UVic's gear get loaded.
Sunday 30 April:	Load the IOS gear using only two pickup trucks. Load UBC, CNL and MUN. Everyone on board by mid-afternoon. Safety meeting at 1500. Keep securing gear and getting everything ready all evening.
Monday 1 May:	Last minute change in personnel. Fixing of main Hawboldt winch. Leave the jetty around 1000. Short science meeting. Station SI03. Fire and boat drill. Stations Haro59, 69, JF2.
Tuesday 2 May:	Complete JF2, 75, P1 to P4.
Wednesday 3 May:	P5 to P10.
Thursday 4 May:	P11 to P13.
Friday 5 May:	P14, P15, start P16.
Saturday 6 May:	Complete P16, P17 to P19. Deploy PROVOR float for IOS at P18.
Sunday 7 May:	P20, P21. Deploy ARVOR float for ONC at P20.
Monday 8 May:	P22 to P35.
Tuesday 9 May:	P26. Deploy PROVOR float for IOS and ARVOR float for ONC at Papa. PA-017. Start heading east, MVP sampling.
Wednesday 10 May:	Heading east, MVP sampling.
Thursday 11 May:	Heading east, MVP sampling.
Friday 12 May:	End of MVP sampling at Scott3. Scott3 and Scott2.
Saturday 13 May:	CPE1, LBA-1, QCS3, QCS1, 16, 14, 12, 9, 6, CPF2.
Sunday 14 May:	3, 2, 24, 22, CPF1, 28, 27, GEO1, 38, 39, 40, 42, 46.
Monday 15 May:	56, 58, GI01, SC04, then arrive at IOS and offload.

CRUISE TRACK:



SUMMARY/FINAL COMMENTS:

- Many thanks to everyone at IOS who packed and prepared all the gear.
- Thanks to Lindsay and Lu for volunteering to sail with us at the last minute. Sorry Lindsay that you ended up staying home! Thank you for all your troubleshooting of TSG and computers during the few hours that you were onboard. Thanks also to Jody for your help with computers issues during the cruise.
- Thanks to Danielle and Mark for joining us at the last minute, and for writing the new termination instructions.
- Thanks to all the people ashore who helped us one way or another: Scott Rose, Chad Paget, Sean Eyding, Stephen Page, Albert Ruskey, Michael Jensen, Saul Bartoli and Céleste Grodesky, Bill Davidson, Kim Houston.
- Thanks to Grace Ho and Steven Hallam for the extra liquid nitrogen.
- Many thanks to the whole galley department for looking after us so nicely. Special thanks to Stacey and Lynn for sailing with us at the last minute.
- Many thanks also to the whole deck crew, with extra special thank you to Hannah and Max for hours and hours spent at various winches.
- To the engineers: thank you for not losing patience with our constant requests.
- And of course thanks to the officers and Captain for keeping us on station. Salisa and Laura, we didn't see much of you but great job getting to and keeping us at the right spots.
- See you all in August?

Marie Robert

- My sincere thanks to the captain and crew of the John P. Tully, the chief scientist Marie Robert, my watch leaders, and all personnel aboard who helped make this a successful cruise.

Olivia Melville

- Thanks to the crew for maintaining wire angles and putting up with long wire times, much appreciated. Special thanks to the cooks and stewards for the delightful meals and great service.

Moira Galbraith

- I am very grateful for the opportunity to be a part of the Line P program. I would like to thank the officers, crew and science team aboard the Tully for their smooth operation of the vessel and its equipment, as well as their good company.

Alastair Roberts

- I would like to extend my biggest gratitude to the entire IOS team for their management, support and help before and during the cruise. Special thanks to my watch leader, Moira, for your unwavering knowledge and inspiration. A further massive thank you to the entire Tully crew- captains, navigation team, cadets, operators, engineers and the amazing cooks and stewards for all that you do!

Rowena Diggle

- I am very grateful to the Hallam Lab for the invitation to participate on this cruise on their only berth and for the opportunity to collaborate. A big thank you to all those who were involved in helping me prepare for this cruise and everyone involved in the transportation of me and my equipment from Germany, to UBC, then to and from IOS, and for those who helped in sampling. Greta Reintjes (U. Bremen/MPI-MM) is acknowledged for supplying the fluorescently labelled polysaccharides.
- I'd like to thank the captain and the crew of the *Tully* for making this a successful Line P cruise. Special thanks to the galley for the excellent and abundant selection of food, and to the medics doling out seasickness medication to all us first-timers aboard!
- I'd also like to thank the science team from IOS, DFO and collaborating institutions for the vibrant atmosphere and for all the discussion, scientific and not. Special thanks to Marie for being extremely responsive leading up to the cruise, and for her patience and calmness from start to finish.

Grace Ho

- I would like to thank the captain and crew of the J.P Tully and Chief Scientist Marie Robert for making this cruise possible and undertaking the planning and preparation to make it go forward. I would like to thank my watch leader, Moira Galbraith, for all the guidance and help provided during the cruise. I would like to thank the other scientists on watch for their hard work and for making the trip a memorable experience.

Julia Fast

PROJECTS AND RESULTS:

Water masses – Marie Robert, DFO/IOS.

During recent years there has been a lot of talk about the presence of Marine Heat Waves in the Northeast Pacific. It seems that there are currently some warm waters at the offshore end of Line P, compared to the 1956 – 1991 averages, but the surface coastal waters seem to have cooled off a lot. The remnants of an eddy can still be seen at depth around P9 – P10 (Figure 1 left). The salinity anomalies are quite striking with a large area of "salty water" between 100 and 200 dbar extending from about P4 to P12 (Figure 1 right). This said, one has to keep in mind that we had many issues with the CTD and the data shown here are non-processed.

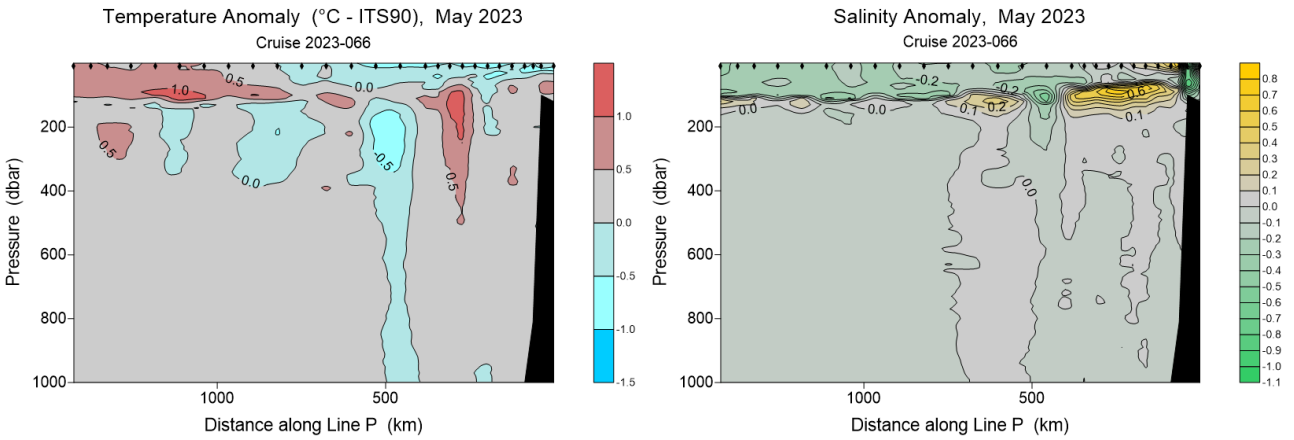


Figure 1: left panel: temperature anomalies along Line P in May 2023 with respect to the 1956 – 1991 averages for May; right panel: salinity anomalies along Line P in May 2023 with respect to the 1956-1991 averages for May. Note that the data have not been processed.

2023-066 Line P Cruise Report – Alastair Roberts, Suttle Lab, UBC

Viruses infect all living organisms, from bacteria and archaea to plankton, whales and trees. Viral infection in the ocean regulates populations of marine organisms, drives evolutionary adaptation and alters the flow of energy through food webs. Despite this, the viruses of most marine animals remain almost completely unknown, and their impacts on marine communities are poorly understood. One such group of organisms is the crustacean zooplankton, whose viruses are largely uncharacterised in spite of their importance in coastal and oceanic ecosystems.

The primary goal of our work along Line P in 2022 and 2023 is to collect abundant marine zooplankton, characterise their viruses by high-throughput sequencing and assess the prevalence and disease impacts of these viruses in host populations in the Northeast Pacific Ocean. The viruses discovered in zooplankton to date span all viral realms with representatives from deep branches of viral evolution. In light of this, our analysis seeks to broadly assess the diversity of both DNA and RNA viruses in this functional group.

On the May Line P cruise in 2023, we collected over 1000 individual zooplankton for analysis, including abundant copepods, amphipods, molluscs and euphausiids. Additionally, nearshore plankton will be collected in the Strait of Georgia (SOG) for greater species coverage of key plankton communities off the B.C. coast.

I am very grateful for the opportunity to be a part of the Line P program. I would like to thank the officers, crew and science team aboard the Tully for their smooth operation of the vessel and its equipment, as well as their good company.

Cruise Report: Line-P 2023-066 – Lu Guan for Roberta Hamme, Ocean Gases Lab, University of Victoria

O_2/N_2/Ar ration (ONAr) samples from the surface waters at every station offshore of P4 were collected to estimate net community production rates. Duplicate samples were collected from a Niskin bottle at 5m depth at each station using glass flask with round or flat bottom containing $HgCl_2$. A total of 46 samples were collected from P4-P26 with the exception of P15, following the sampling videos and instructions provided by Dr. Roberta Hamme (Ocean Gases Lab, University of Victoria). The flasks with collected samples were stored in an aluminum box with a 1" thick piece of foam over the flasks at the top.

Silicon cycle and phytoplankton – Olivia Melville, Varela Lab, UVic.

Phytoplankton form the base of the marine food web and are extremely important in large-scale Earth processes such as oxygen production and carbon sequestration. The physiological processes of phytoplankton link the ocean, atmosphere, biosphere and lithosphere together in a global biogeochemical cycle. Diatoms, a group of highly abundant phytoplankton, build their shells out of silicon thus linking global carbon and silicon cycles. To understand the particular role that diatoms play in the ocean, we can investigate the marine silicon cycle to see how silica concentrations in the ocean fluctuate during the growth and decay of blooms. The standing stock of biogenic silica is often used as a proxy for diatom abundance, however, other silicifiers are present in the water column. Siliceious Rhizaria are zooplankton which take up silicon to create their skeletons. While less abundant than diatoms, Rhizaria are much larger and therefore take up more silicon per individual. Their relative contribution to the global silicon cycle is not well known but is thought to be underestimated. This group is highly understudied in the Northeast Pacific.

Water parameters and zooplankton tows were collected at 5 stations along Line P to examine the relative contribution to the silicon cycle of Rhizaria compared to diatoms. Parameters measured include dissolved and particulate nutrient concentrations, chlorophyll-a and preserved phytoplankton and Rhizaria specimen. Water was sampled from depths between 100m and 5m using Niskin bottles. Rhizaria were collected from vertical bongo net hauls from 1200m using a 236 micron mesh vertical net bongo tow.

At each depth, duplicate dissolved silica (dSi), dissolved nutrients and phytoplankton ID samples were collected. Duplicate particulate biogenic silica (bSi), particulate organic nitrogen and particulate organic carbon samples were also taken. In the euphotic zone, transparent exopolymer particles (TEP) and total chlorophyll-a were measured. Natural phytoplankton assemblages were incubated with 32-Si, a radioactive tracer, to examine the uptake rate of silicon. From bongo net hauls, Rhizaria were picked and incubated for 48 hours with Si-32. Each incubation included specimen from the same family (Spumellaria or Phaeodaria). At the end of the 48 hours, incubations were terminated to determine silicon uptake rates.

Acknowledgements

My sincere thanks to the captain and crew of the John P. Tully, the chief scientist Marie Robert, my watch leaders, and all personnel aboard who helped make this a successful cruise.

Cruise Report: Line-P 2023-066 – Stephanie Walsh, Canadian Nuclear Laboratories.

Stephanie Walsh from Canadian Nuclear Laboratories located in Chalk River, Ontario, participated in the Line P cruise to collect samples to support the development of a baseline for radionuclides (tritium and gamma emitters) for marine ecosystems of Canada's west coast. From Fukushima in Japan, radionuclides have been removed from water using an Advanced Liquid Processing System (ALPS) until radionuclide concentrations have reached a sufficiently low concentration, meeting regulatory requirements, these waste waters will soon be diluted with sea water and discharged into the sea. Eventually, released ALPS treated water will arrive at the Canadian coast across the Pacific Ocean after 2 -3 years following its release. Prior to its arrival, we must validate the impacts for the Canadian Public by measuring ultra-low level tritium (HTO) and organically bound tritium (OBT) as well as gamma emitters from marine ecosystems (water and biota). Target concentrations of radioactive water for TEPCO are 1 Bq/L for Cs 137 and Cs 134, 5 Bq/L for gross beta and 1500 Bq/L for tritium, all of which are many times lower than the limits for drinking water established by the WHO.

Along Line P, stations P1 through P26 (minus P15 due to rosette issues) were sampled for tritium, iodine-139/137 and stable isotopes, with depth profiles (5, 15, 25, 40, 60, 100, 200, 300 m) collected at P4, P16 and P26. Samples for cesium-137/134 analysis were collected at 5 m at stations P2, P4, P8, P12, P14, P16, P18, P20, P22, P24 and P26, with depth profiles (5, 15, 25, 40, 60, 100, 200, 300 m) collected at P16 and P26. Coastal samples were collected for tritium, iodine and stable isotopes at stations 16, 9, 2, 27 and 46. Three coastal stations were sampled for cesium-137/134 analysis (CPE1, 16, 2).

The work from this cruise will help to establish background levels of radionuclides and understand their behavior and transport in marine water from the Canadian West coast prior to the arrival of ALPS wastewaters from Fukushima.

Cruise Report: Line-P 2023-066 – Kavi Heerah, Memorial University of Newfoundland.

"Collecting total organic carbon (TOC), dissolved organic carbon (DOC) and chromophoric dissolved organic matter (CDOM).

These are all measures of the carbon in the water. The difference between total and dissolved is due to filter size, anything through a 0.2µm is considered truly dissolved. This sampling (TOC and DOC) tracks the flow of carbon from the continental shelf to the open ocean and down to the depths. CDOM can help give properties of the organic matter in the ocean, giving information about its source (bacterial or terrestrial), an idea of the productivity of the ocean at various depths, such as if there is lots of bacterial protein present and an idea of the molecular size of the carbon through the transect. Samples for CDOM and DOC were collected at all rosette stations. For major stations; P2, P4, P8, P12, P16, P20, and P26 we collected DOC, TOC and CDOM. This 'duplicate' sampling is to be used to confirm if there are significant differences between TOC and DOC in the marine environment. If it is determined to be insignificant, future sampling trips will only collect CDOM and TOC, reducing total amount of samples and time spent collecting samples. In total 607 samples were collected.

There were no major problems collecting samples. A minor problem was issues with the initial flow filter to use. The risk of contaminating samples is high, and it is recommended future sampling ensures samples are not opened in the lab due to ethanol and other organic solvents being used in the lab. Acidification should be carried on the rosette deck and if possible acid used for fixing the carbon should be stored in a chemical locker outside the main lab to avoid the risk of solvent contamination.

Cruise Report: Line-P 2023-066 – Rowena Diggle, UBC.

Background:

Silver is classified as an environmental hazard ascribed to its high toxicity and strong tendency to bioaccumulate in aquatic biota. Silver is widely used in pharmaceuticals and medical applications and with increasing commercialization the amount of Ag being discharged into the ocean is likely to increase. The intricate nature of sampling nanosized concentrations and high risk of contamination creates challenges in sampling. Therefore, previous measurements of silver in the Salish Sea and surrounding Pacific waters are very limited, with few measurements conducted during winter and early spring. The Line P cruise provides a perfect opportunity to conduct trace metal sampling to constrain previous measurements and enhance our understanding of transport dynamics. Forming part of a Master of Science Research thesis, the research conducted on board the John P Tully ship will contribute valuable data to constraining silver measurements in the water column in the SoG and surrounding Pacific waters.

Further to trace metal sampling in the ocean, the Line P program has been successful in allowing the continued investigation of temporal trends in Asian-derived aerosols. The aerosols undergo long range transport due to strong westerly winds; and are very chemically diverse. They originate from both lithogenic and anthropogenic sources, with transit mixing altering their composition and solubility, resulting in deposition to the ocean. The resulting oceanic ratio of essential to toxic trace metals, as well as their bioavailability can thus have an effect on phytoplankton communities.

Sampling along Line P included multiple Go-Flo casts to collect water samples at multiple depths, which will also be paired with CTD data to correlate physical properties. One cast was conducted at JF2 over seven depths - 15, 40, 80, 100, 120, 140 and 165 m. The second cast was deployed at P4 over two rounds to capture all desired depths – 10, 35, 50, 75, 100, 150, 200, 400, 600, 800 m. Once collected, samples were then filtered into acid clean collection bottles to capture the dissolved fraction of the sample, for further analysis in the lab.

Aerosols were collected on Monkey's Island along the entire Line P transect using a Total Suspended Particulate Volumetric Flow Controller High Volume Air Sampler (TE-5170V-BL). This instrument was connected to an Instromet Weather Systems Ltd wind speed and direction switch, in order to avoid the Tully's stack exhaust. These samples will be used to determine trace metal concentrations, solubilities, and deposition fluxes, as well as lead isotopic ratios.

I would like to extend my biggest gratitude to the entire IOS team for their management, support and help before and during the cruise. Special thanks to my watch leader, Moira, for your unwavering knowledge and inspiration. A further massive thank you to the entire Tully crew- captains, navigation team, cadets, operators, engineers and the amazing cooks and stewards for all that you do!

Microbial sampling Line P May 2023 – Grace Ho, Flow Cytometry Research Group, Max Planck Institute for Marine Microbiology (MPI-MM) for Hallam Lab (UBC)

Objectives

- Sample a subset of Line P, building upon over a decade of microbial sampling in Saanich Inlet and Line P.
- Describe taxonomic and metabolic diversity of microbial communities in the cycling of major nutrients along Line P.
- Collect environmental seawater samples for methods validation of a pipeline to derive protein expression data from cells sorted by fluorescence-activated cell sorting (FACS).
- Characterise and quantify "selfish" uptake of marine polysaccharides in bacteria in coastal the (Saanich Inlet) and oceanic (P4) environment via fluorescently labelled polysaccharides (FLA-PS).

Sampling Summary:

At SI03 (16 depths), P4 (8 depths), P26 (17 depths):

1. 2 l of seawater was filtered directly onto 0.22 µm at each depth for high-resolution (HR) bacterial DNA sequencing.
    a. At SI03, filters for RNA were collected, but 1 hour after collection due to a scheduled fire drill.
    b. A second bottle at 10 m did not fire; one bottle for DNA filter was repurposed for FLAPS incubations (4) and fixation (3).
2. ~5 ml of seawater was preserved in glycerol/Tris-EDTA buffer for isolation and sequencing of single-cell amplified genomes (SAGs).
    a. Due to a miscommunication and some interruption from the fire drill, at least five depths were not collected.
3. 10 ml of formaldehyde-fixed seawater was filtered for microscopic analyses. With this, we can derive bacterial cell abundances via automated cell counts and absolute cell counts of specific bacterial groups using fluorescence *in situ* hybridization (FISH) of the 16S ribosomal RNA gene.

    At 10 m only:
    a. Additional 100 ml (x3) samples were filtered for FISH of functional genes (gene-FISH). (MPI-MM)
    b. Additional 500 ml samples sequentially filtered through a 3 µm filter, then a 0.2 µm filter, for 16S FISH and subsequent FACS and downstream proteomics. (MPI-MM).

At SI03 and P4:

4. Three 1 l samples and one 500 ml-control sample were collected and amended with fluorescently-labelled polysaccharides relevant to the marine environment (laminarin, xylan, fucoidan). After day 4 and 7, sub-samples for DNA, flow cytometry and microscopy were taken for bacterial community analysis (MPI-MM).

At P4 and P26:

5. 2 l of seawater was collected on pre-combusted GFF-75 filters for particulate organic matter analysis (Crowe Lab, UBC)

Comments

This cruise marks the first sampling of Line P from/for the Hallam Lab since 2019, albeit at a far smaller scale. The inclusion of SI03 and sampling of nutrients was highly appreciated. Our initial plan included five additional sampling depths for P4, collection of filters at for RNA and Protein at SI03, P4, and P26, as well as filtered nutrients and H_2S at SI03. However, due to travel fatigue and seasickness, reducing the sampling to DNA, SAGs, POM, FISH/microscopy and FLAPS incubations was deemed necessary.

Although I collected fewer sample types than originally planned, I consider this cruise a success. This was my first Line P cruise, and the first expedition of this length. I have no doubts some interesting findings will come out of the samples and I am excited to see what I find under the microscope and at the flow cytometer.

I am very grateful to the Hallam Lab for the invitation to participate on this cruise on their only berth and for the opportunity to collaborate. A big thank you to all those who were involved in helping me prepare for this cruise and everyone involved in the transportation of me and my equipment from Germany, to UBC, then to and from IOS, and for those who helped in sampling. Greta Reintjes (U. Bremen/MPI-MM) is acknowledged for supplying the fluorescently labelled polysaccharides.

I'd like to thank the captain and the crew of the *Tully* for making this a successful Line P cruise. Special thanks to the galley for the excellent and abundant selection of food, and to the medics doling out seasickness medication to all us first-timers aboard!
I'd also like to thank the science team from IOS, DFO and collaborating institutions for the vibrant atmosphere and for all the discussion, scientific and not. Special thanks to Marie for being extremely responsive leading up to the cruise, and for her patience and calmness from start to finish.

May 2023 Line P Trip Report – Julia Fast, UBC.

Zooplankton are crucial components of marine food webs, making up a key link between primary producers and higher trophic level organisms such as marine fish and mammals. The nutritional quality and quantity of zooplankton prey for these higher trophic organisms is seen as an important component of early marine success for juvenile fish. More nutritious zooplankton prey can improve growth and health, leading to better predation avoidance and resilience for these organisms and ultimately increasing survival.

Zooplankton prey that are higher in fatty acids essential for organism health and development are considered of greater nutritional quality. Different zooplankton species differ in composition of these essential fatty acids. My Masters project aims to understand regional differences in zooplankton nutritional quality along the BC coast and offshore where ocean conditions differ. This can provide insight into how future changes in ocean conditions as a result of climate change may impact zooplanktivorous organisms, as well as provide insight into one potential factor in fish population declines.

Line P provides the opportunity to build up fatty acid information for offshore zooplankton species, which can be compared to coastal/shelf regions where more species-specific fatty acid data is available. Along Line P, I collected zooplankton species commonly found offshore from IOS bongo net casts (using a 250 µm mesh size net) at P2, P4, P12, P16, P20 and P26. These casts ranged from 110m to 1200m in depth. Collected zooplankton will be analyzed for fatty acids using gas chromatography at the Pacific Science Enterprise Centre in Vancouver, BC, and used to compare differences in zooplankton nutritional quality offshore and in coastal regions of BC based on the composition of essential fatty acids.

Acknowledgements

I would like to thank the captain and crew of the J.P Tully and Chief Scientist Marie Robert for making this cruise possible and undertaking the planning and preparation to make it go forward. I would like to thank my watch leader, Moira Galbraith, for all the guidance and help provided during the cruise. I would like to thank the other scientists on watch for their hard work and for making the trip a memorable experience.

Cruise Report: LP23a – Jody M. Klymak, University of Victoria

MVP Installation




Software wise, the Tully has a UDP box (in the back of the science rack) that serves UDP packets from the Science GPS (10.248.237.222:1025) and the EA600 12 kHz echo sounder's depth value (10.248.237.222:1029). These were listened to with mvpserver (username and password are also mvpserver) which was a mac laptop stored in the MVP rack. On that machine mvp_relay listened to the UDP packets and relayed them to the MVP acquisition program on the MVP computer. This all worked fine, except bottom detection sometimes failed on EA600 in rough seas.

MVP operations

Deck tests at IOS were successful.

A manual cast in Saanich Inlet was successful.

In Saanich Inlet we put fish in water and had ship increase speed to 8 knots. Line out to 70 m was good for the messengers, so we put them at that distance.

The main MVP section was from PA017 10 May 0028 UTC to Scott3 13 May 0127 UTC. We completed 767 CTD casts from the surface to 200 m depth in all types of weather.

The MVP fish cleared the aft rail if the fish was brought up as high as the termination would allow, so we were able to easily interoperate with the bongo nets, which were also deployed on the starboard quarter.

Recovery was usually straight forward; fish was taken out twice at noon, for a quick inspection.

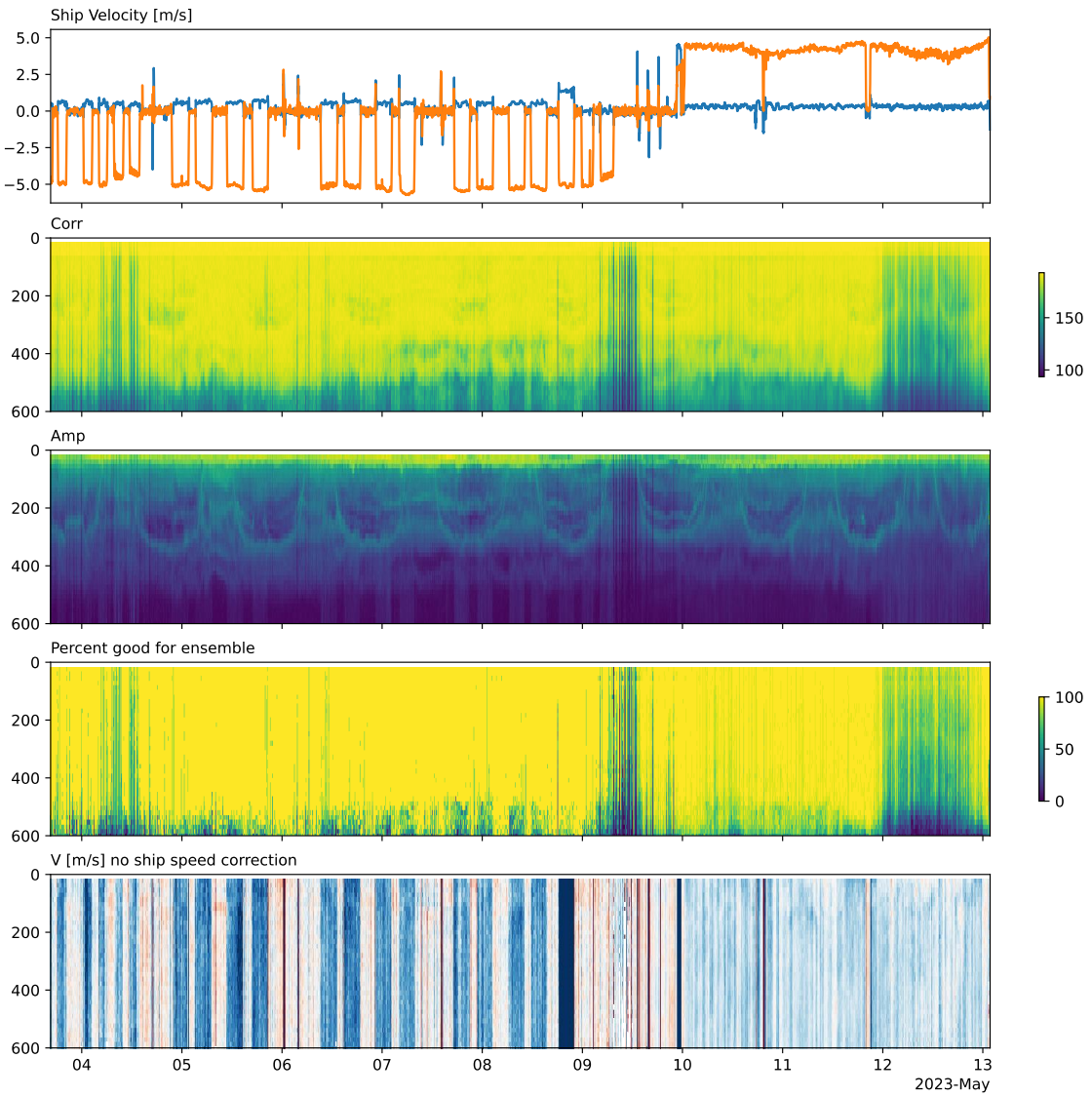
We had a couple of sharp turns during the second recovery while the fish was still being towed, both on recovery and redeployment. Otherwise the ship handling was good.

The MVP had a few cases of the messenger slipping out of the sheave before the cast, leading to aborted casts. Inspection of the winch showed that the brake cylinder had a mild leak. I put a diaper under the cylinder, and the winch stopped slipping soon thereafter, so some oil was probably getting on the drum, and then getting washed off. Brake cylinder needs replacing, or the seal perhaps can be replaced. Note the serial number is SFH158x4-SCR-FT-HYD from Compact Automation Products. Look like they still make it, and there are repair instructions as well.

ADCP operations

The ADCP setup was fine, except I forgot to check that the navigation data was set up properly. For some reason it had been reset to being off. It *used* to go through the serial line emulator, but that just uses the UDP packets, so I changed to listen to the UDP ports directly.

For most of the cruise we used IOS_NB_NoBottomPing.txt. After Station P, I turned off the ping syncing with the EK80 because the EK80 was only pinging every 7-11 seconds, whereas the ADCP was capable of 2.5s (commented out the CX 1, 0 line in IOS_NB_NoBottomPing.txt). IOS_NB_BottomPing.txt was used in shallow water, and was always syncing with EK80.

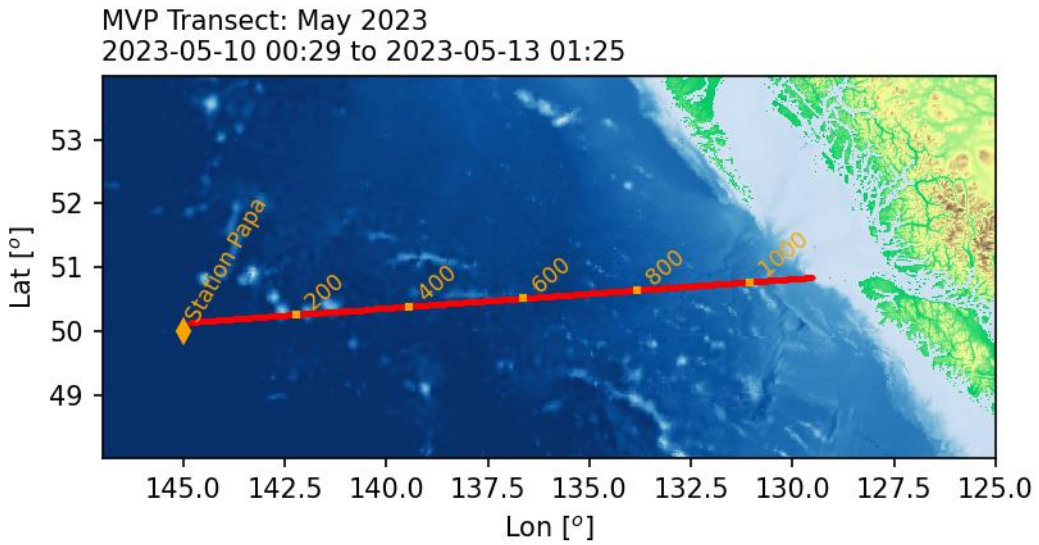


ADCP Health Line P trip

The EK80 slow pinging issue appeared to be caused by settings on the EK80. The 7-11 second ping rate didn't resolve itself, even in shallow water, until I turned bottom detection on for all four frequencies, and set the maximum distance to 500 m (from 5000 m we were using in open water). At that point, the sounders dropped to a 2-s ping rate. It seems that even if the bottom detection is turned off for one of the sensors, it will use this maximum value to determine how long to put between pings.

The other issue with the slow pinging of the EK80 was that if the ACP was stopped you had to be quite lucky to get the ADCP to sync with the EK80 before it timed out. Removing syncing, the ADCP would pig right away.

Data

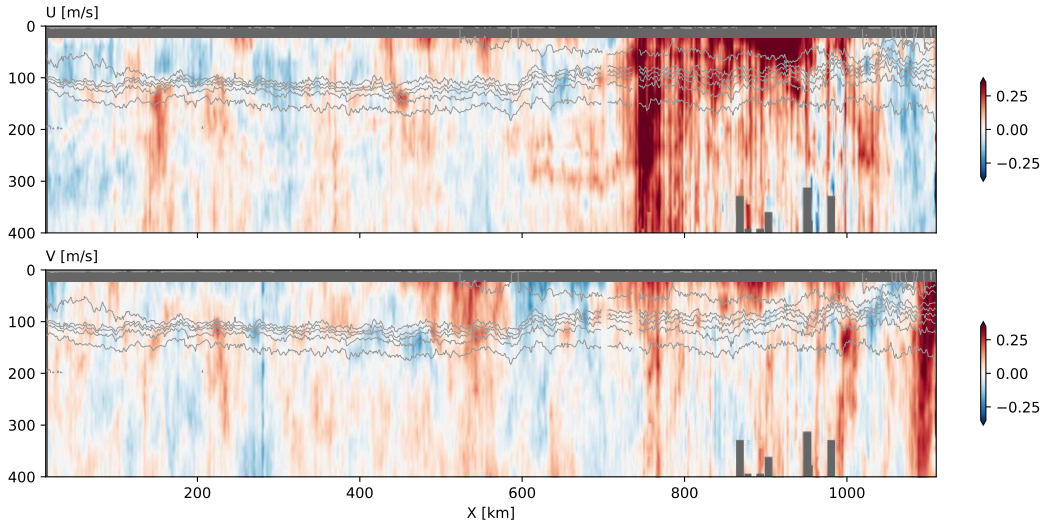


ADCP

ADCP data was logged using VM-DAS and monitored using WinADCP. Data comes in UDP ports supplying feeds NMEA1 and NMEA2 to VM-DAS; for the data analysis here we will look at the short-term-averages, which are composed of 120-s ensembles.

Data is corrected for ship motion using the GPS to compute the ship's speed over land. Heading comes from the navigational gyro. So far as I can tell, there is no pitch or roll sensors on the Tully.

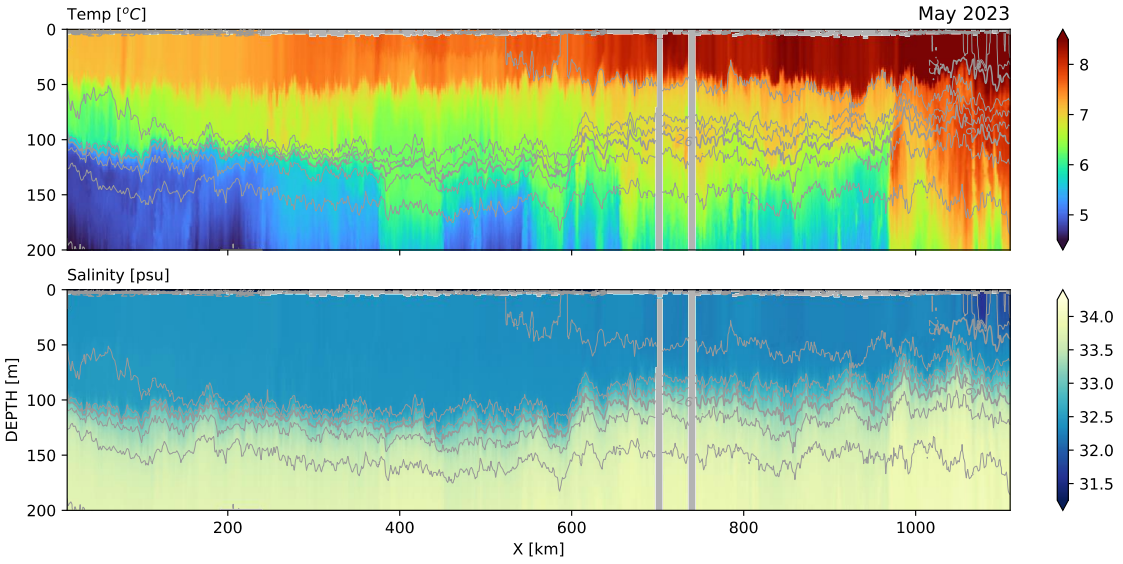
There was a relatively bad storm (> 35 kts) after X = 650 km that made the data quality from the ADCP quite poor. It's possible there is enough good data in the bad to get reasonable velocities. It's also possible the ship had a net pitch during this time that pushed ship speed into the earth velocity.

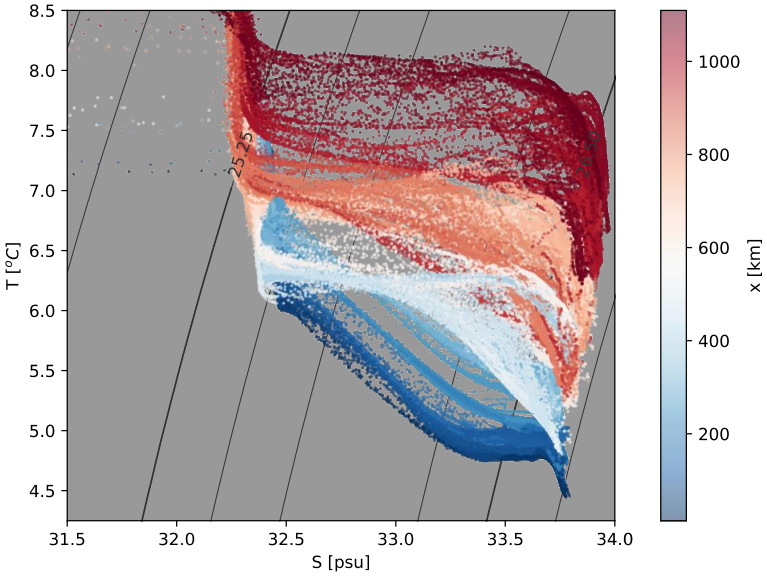


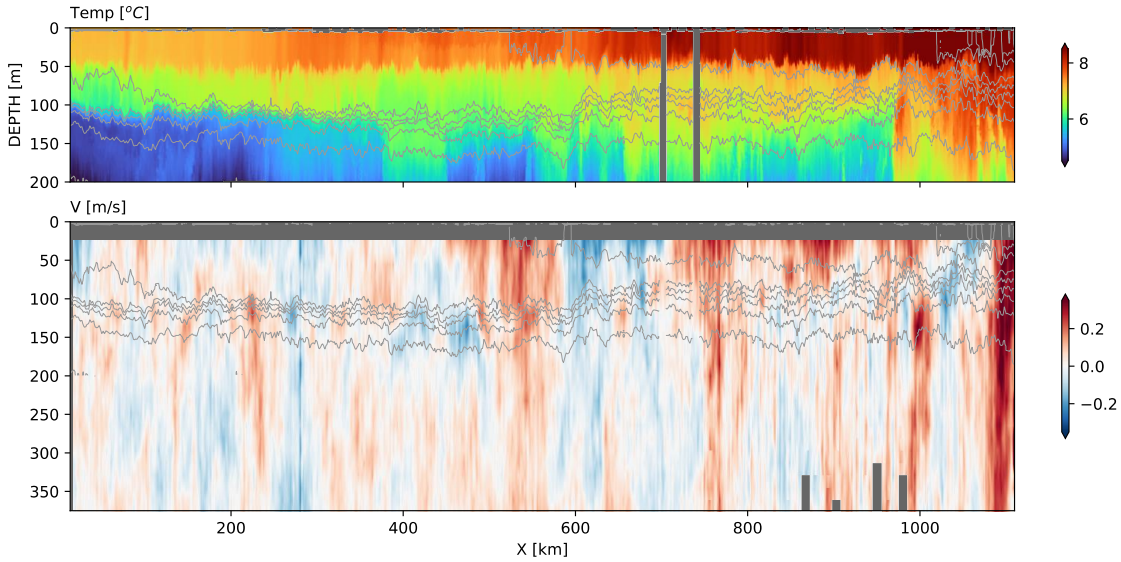
MVP

The mixed layer shows substantial variability during the section, showing signs of significant stratification even this early in the year and during relatively strong winds (). Salinity is well-mixed to 100 m or so, but there is some temperature stratification along most of the section.

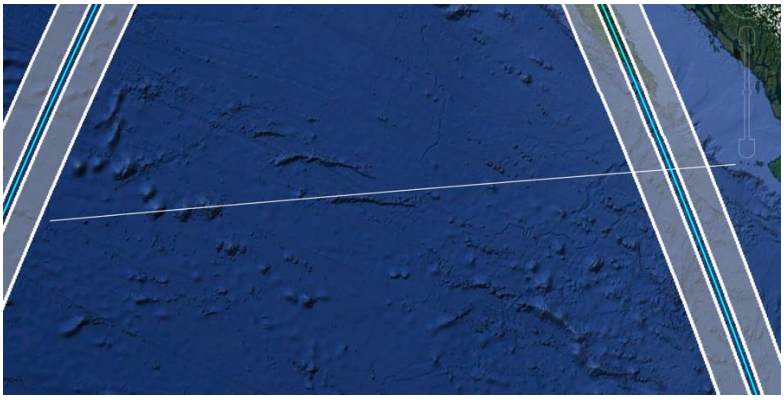
As with other Line P sections the data shows strong coherent along-line variability down the submesoscales. Data also clumps in T/S space. Combined with the other two sections (Feb 2022 and Aug 2022) and hopefully the upcoming Aug 2023, this is going to be a very interesting data set.







Note that our track directly crossed under the SWOT track near Cape Scott.



Issues and recommendations

- Still some confusion about acoustic setups. 1000 ms is not achievable by any of the sounders. On the other hand, the EK80 should not need to ping at 7 to 10 seconds. I'm also not clear why the CTD folks use the EK80 for bottom depth instead of the 12 kHz EK600 – by setting the EK80 to cover the whole water depth the ping rate is degraded, whereas if the EK600 were used the EK80 could ping faster.

- It would be preferable if the TSG were not running on the same computer as the ADCP. It seems the server would be fine for running this?