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:** 20 August 2013 **TO:** 5September2013

SCIENCE CRUISE NUMBER: 2013-18 **SHIP'S PATROL NUMBER:** 13-06

CHIEF SCIENTIST[S]: Marie Robert

SCIENTIFIC PERSONNEL:

Female	Male
Carolyn Duckham (UBC)	Michael Arychuk (IOS)
Moira Galbraith (IOS)	Robin Bénard (U. Laval)
Hollie Johnson (UVic)	Glenn Cooper (IOS)
Martine Lizotte (U. Laval)	Sam Kheirandish (UBC)
Maite Maldonado (UBC)	Hugh Maclean (IOS)
AniaPosacka (UBC)	Ernesto Martinez (U. Berkeley)
Marie Robert (IOS)	Andreas Mueller (UBC)
Christina Schallenberg (UVic)	
Nina Schuback (UBC)	
NariSim (UBC)	

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 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. Perform intense Trace Metal sampling. Deploy two weather data drifting buoys for Environment Canada.

CRUISE DESCRIPTION: This cruise (2013-18) was a success in terms of work planned versus work done at each station. All stations were visited and all casts performed, although a few casts had to be done on the return leg because of bad weather while sailing west. The Trace Metal Rosette and Winch worked as expected, as did the Hydro Winch. We deployed two weather data drifting buoys for Environment Canada.

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

DAYS LOST DUE TO WEATHER:only a few hours.

SAMPLING:

- The Line P survey was 100% successful. All planned stations were visited and all planned profiles got done, although two Trace Metal Rosette (TMR) casts had to be done on the way back.
- Twoweather data drifting buoys were deployed for Environment Canada.
- The set-up for the Trace Metal Rosette (TMR) worked really well, even without a weight under it. Two or three TMR casts were performed at each major station, as well as some pumping with the Teflon pump. Extra sampling was done at Station P with the Go-flos. The TMR was used again at P12 on the return trip.
- Extra sensors (two Particulate Inorganic Carbon – PIC – sensors and a transmissometer) were added to our CTD by/for the University of California, Berkeley.
- The samples collected include:
  1) Underway: **IOS**: Thermosalinograph (Temperature, Salinity, Fluorescence), acoustic sounder, ADCP, pCO_2.
  2) "E-data" from CTD: Pressure, Temperature, Conductivity, Dissolved Oxygen, Transmissivity, Irradiance, Fluorescence (only one sensor), PIC.
  3) From the Rosette: **DFO-IOS:** dissolved oxygen, salinity, nutrients, DMS, DMSP, chlorophyll, HPLC, dissolved inorganic carbon (DIC), alkalinity, pH– **UBC (Mueller, Kheirandish, Schuback):**dissolved nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), argon (Ar), nitrous oxide (N_2O), number of cells per millilitre, hydrogen sulfide (H_2S), bacterial genomic (DNA, RNA) and sequencing, HPLC, Chl*a*, FCM, POC, ^{14}C primary productivity, FRRF, absorbtion, nutrients, salinity– **UVic (Johnson):** dissolved oxygen, O^{17}, ONAr (Oxygen, Nitrogen, Argon), Noble gases, salinity – **U. Berkeley (E. Martinez):**particulate inorganic carbon (PIC).
  4) From the pump/Trace Metal Rosette/Go-Flos/incubators:**UVic–UBC (Schallenberg, Sim, Maldonado, Posacka): d**issolved and particulate iron, Fe (II), dissolved and particulate manganese, cadmium isotopes, – **U. Laval (Bénard, Lizotte):** DMS, DMSP, DMSPd, HPLC, Virus – Bacteria – Phyto (Cytometry), Nutrients, DIC, pH, Alkalinity, N_2O, primary production (^{14}C), Chl*a*.
  5) **DFO-IOS (Galbraith):** Zooplankton using vertical net hauls(Bongos) to 250 m and 1200 m, with an additional 2000 m bongo cast at P26.

RADIOISOTOPE USE:

The following radioisotopes were used in the Rad-Van:^{14}C-bicarbonate, ^{3}H thymidine, ^{67}Cu Chloride, $NaH^{14}CO_3$ solutions. Wipe tests were done in all appropriate areas of the ship every seven days and upon completion of the studies. The lab was inspected and decommissioned at the end of the cruise.

PROBLEMS [SCIENTIFIC GEAR AND OPERATIONS]:

The thermosalinograph (TSG) would not communicate with the computer at the beginning of the cruise. On day 3, after trying many different things and after a phone call to Seabird, the communication was finally established. The TSG was set-up with a new arrangement of filters all mounted above the TSG. When the water started to circulate through the system an air pocket was created that prevented the water from getting to the TSG without bubbles. So the whole system got modified again to first go through the de-bubbler, then go through the new filters. Even with the de-bubbler in line air pockets were still a problem. Thanks to the engineers for adding valves to the new filters to try to get rid of the problem. By the time we got to Station P the salinity signal – the signal most influenced by the bubbles – was finally a lot more stable. But then the day following our departure from Station P it was noticed that since the TSG was started no data were being archived. So we will only have TSG data from about P24 to Pat Bay, one way, although it seems that the SCS recorded some data on the way out. The following day it was noticed that the flow meter was reading 0.0 ℓ /s. While we re-visited station P12 the flow-meter was taken apart and fixed; there was a very small mussel that was blocking the rotating wheel. So the water should flow from the manifold to a filter, then to the de-bubbler, and lastly to the flow-meter to then be divided between the fluorometer and the TSG. Even better would be to have two independent flow-meters: one for the fluorometer and a separate one for the TSG. Thanks to the Chief Engineer for taking apart the flow-meter.

There were also a few problems with the configuration file of the CTD. The main – and very important and unfortunate – problem was that two sensors were not mounted as described in the configuration file. Indeed, our fluorescence sensor and one of the Bishop sensors were on reverse channels. During a downcast the CTD operator looks for a maximum in fluorescence in order to collect water at that "Chlorophyll maximum". Since the channels were reversed, we were not looking at the correct signal on the screen and therefore missed all the potential maxima. We also could not adjust the gain cable for the fluorescence – since we were not looking at that fluorescence signal.
Another problem with the configuration file is that some people were using the main CTD computer to look at archived data, and while doing so were modifying the configuration file, so that the information in that file did not always reflect the cable used on the CTD. It might be good practice to do a "lock screen" from now on between stations.

There seems to be some glitches on old XP computers trying to connect to the Science Server, which is a Windows 7 computer. They get disconnected randomly, whereas the Windows 7 machines never have that problem. We often could not print the rosette logs from the label laptop since the latter could not see the printer on the server. It would be good to get all laptops upgraded to Windows 7.

The ADCP software stops working regularly and needs to be restarted on a daily basis.

During day 2 at Station Papa (31 August) it was observed that the pCO_2 system was giving an error code on the LICOR analyzer. Upon investigation it was observed that the code was in response to a kinked line on the front of the instrument. The line was probably kinked by someone who accidentally knocked the system as they were walking past. In any case the line was repaired, the system re-started and a couple of hours later the preliminary data looked good. The next day the system was checked to confirm proper operation and it was noticed the error had returned. Over the next couple of days several diagnostic tests were done to no avail. It is not known if the two errors are related or if the first error caused undetected damage which caused the second error. Presently the system is non-operational and may have to be diagnosed in a lab setting with proper tools.
Michael Arychuk

Again there were some problems with DFO Windows 7 computers not being able to see the ship's network. Thanks to IstoProkki and Lawrence Kuromifor spending a few hours on the ship while in Pat Bay to fix this problem so that I could use my laptop while on board. Marie Robert

While stopped at P20 on the return leg to fill a few carboys with the trace metal pump, the hoses got tangled and the pump fell on the deck. The plastic screws holding in air intake hose broke and the pump could not be used. Fortunately it was the last time during this cruise that the pump was needed.

We had three thermometers for dissolved oxygen sampling on board. While using all three on a single Niskin bottle we had differences of up to 6°C between them all! It is mandatory that these thermometers get A. identified so that we know which one we are using and can write down when there's a change of thermometer because the battery is dying, and B. that they get calibrated!

SUCCESSES [SCIENTIFIC]:

Every group emailed me their water requests and sampling plan before we sailed, which made the science meeting must smoother and helped solve some issues before we even set foot on the ship. Thanks to everyone for this. Special thanks to Christina and Maite for so many back-and-forth emails to develop the working plan.

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

The tape at the very end of the termination wire above the rosette is constantly fraying and needs to be re-taped every few casts.

The Moyno pump supplying water to the TSG, incubators, and is being used to rinse the bongos failed towards the end of the cruise. Fortunately the "old pump" (the Roper pump) was available as a back-up.

SUCCESSES [SHIP]:

Loading the scientific gear first on loading day then dealing with the winches and containers the next day allowed us to set-up and secure all the instruments in the lab. It is a very good order of operations.

Thanks to the engineers for adapting the "emptying of the tanks" and the burning of garbage around our work on long stations.

Thanks to the crew for all their help when doing bongos, TMRs and go-flos.

DELAYS [OTHER THAN WEATHER]:

None.

SAFETY CONCERNS:

None.

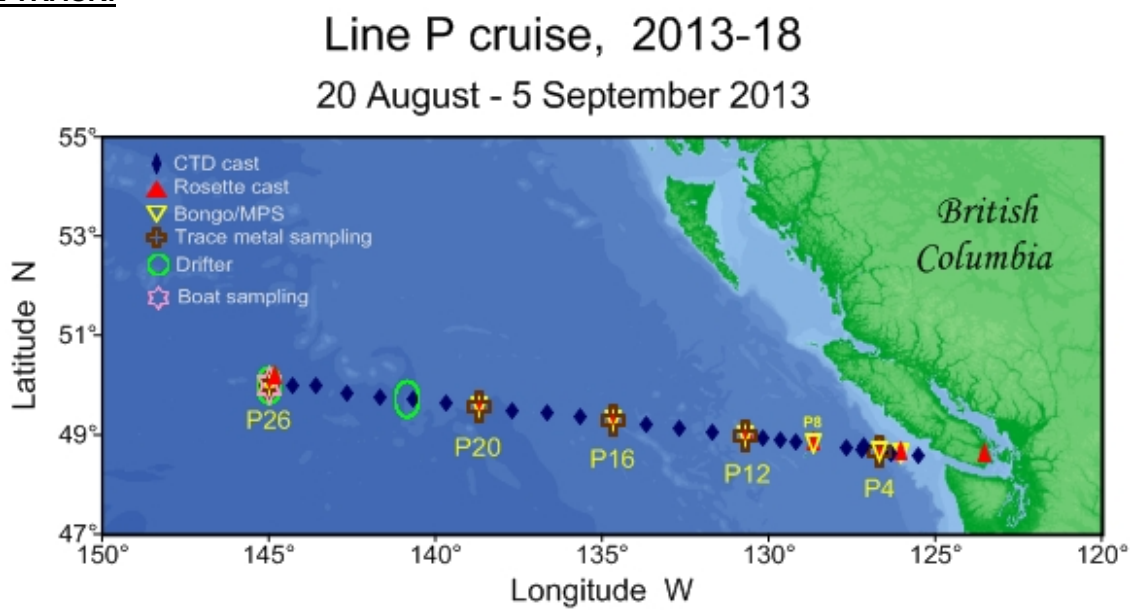
HAZARDOUS OCCURRENCES:

Two incidents involving scientific personnel.
One small bottle of Glutaralhehyde 25% fell and broke in the lab. It was promptly acknowledged, contained, and cleaned.

EVENT LOG:

Tuesday 20 August:	Start loading the ship at IOS around 1300.
Wednesday 21 August:	Safety meeting at 1000. Fire and boat drill at 1300. Leave the jetty around 1430. Saanich Inlet cast.Leave for P1 around 1600.Science meeting at 1800.
Thursday 22 August:	Stations P1 to P4.
Friday23 August:	Stations P4 to P7.
Saturday 24 August:	Stations P8 to P12.
Sunday 25 August:	Stations P12 to P14.
Monday 26August:	Stations P15 to P16.
Tuesday 27August:	Stations P16 to P19. Deploy EC weather drifter.
Wednesday 28August:	Stations P20.
Thursday 29August:	Stations P21 to P24.
Friday 30 August:	Stations P25, P35. Arrive at Papa around 1400. TMR-1, DMS, shallow ^{17}O and UBC/ONAr casts, and 3 bongos.
Saturday 31 August:	DeepONAr, TMR-2, Light cast, thenONAr cast at PA-007 mooring site. Back to Papa for IOS Deep cast and go-flos to 4000m. Deploy EC weather drifter as we leave Papa.
Sunday 1 September:	Stop at P20 for pumping in the chains but pump not working.
Monday 2 September:	Loop sampling.
Tuesday 3 September:	P12, two TMR casts and 2 rosette casts.
Wednesday 4 Sept:	P4: rosette cast and go-flos.
Thursday 5 September:	Arrive at IOS and offload.

CRUISE TRACK:



SUMMARY/FINAL COMMENTS:

- Many thanks to everyone at IOS who have helped make this cruise a success:Doug, Kenny, Kyle, Tamara, Mark, Melissa, Marty, Darren … your help is always greatly appreciated!
- Thanks to the engineering group for constantly adjusting the "tank schedule" and burning around our sampling schedule.
- Finally, big thanks to the galley crew for looking after us so well and feeding us too much! The daily salads were awesome, and as usual the BBQ was fantastic, thanks!!! ☺

  Marie Robert and the science team.

- Thanks to IstoProkki and Lawrence Kuromi for spending a few hours on the ship while in Pat Bay to try to fix my "Windows 7 laptop" so that I could use it while on board.

  Marie Robert

- The trace metal team would like to thank Marie Robert for being very accommodating with all the "special" TMR requests, the Tully's captain, officers and crew for safe operations and helping well beyond their "mandate", and all the scientists who contributed as "dirty hands", operators of the heave compensator, and GO-Flo carriers. You all helped making this a very successful trace metal cruise!

  The Trace Metal team

- Our group would like to thank Marie Robert for all her help and patients while preparing for and during this cruise. Our group had a lot planned for this cruise and we got a lot of help from everyone, which we appreciate a lot! Thank you for providing all the extra lab, fridge and freezer space and the use of the pump. Also, special thanks making sure Nina's Light Cast always happened at the right time of the day. Very special thanks also goes to Mike Arychuk, who made it possible for all of us to work in the rad van and to get our radioisotopes to IOS. We would also like to thank Melanie and Kyle for helping us with all our radioisotope requests. Thanks also goes to Mike for help with receiving gasses for the MIMS and the liquid nitrogen for our group. Also a big thanks to Hugh Maclean for his patience during the pumping sampling, the watches, and his big smiles at all times.

  The Maldonado-Tortell group.

- We wish to thank the Tully crew for their assistance and excellent work throughout the cruise. Thanks to Marie Robert and the scientists onboard for their help on deck and in the lab.

  Sam Kheirandish and Andreas Mueller

- Deck crew did an excellent job of handling the idiosyncrasies of the bongo winch and bridge were great at dancing the ship to keep wire vertical, much appreciated.

Moira Galbraith

- Thank you to the Captain and the Red Crew of the J.P. Tully and to IOS personnel Marie Robert, Hugh Maclean, and Moira Galbraith. Thank you all for working together so well. Your exceptional planning, organization, and collaboration made this research cruise successful. We appreciate all of the hours spent operating the winch, spent in the closet communicating with the rosette, working behind the scenes to keep operations running smoothly, working to keep us square on station, and scheduling in our sampling requests. Many thanks to the cook, Bert Farwell, for preparing so many delicious and healthy meals and for being so accommodating to dietary constraints. We would like to thank IOS for providing salinity sampling bottles and performing analysis of salinity samples. Thanks everyone!

Hollie Johnson

- We would like to thank Robin Bénard, Martine Lizotte and Andreas Mueller for assisting in poisoning, and sealing the DIC samples.

Glenn Cooper

- After 7 years of close collaboration with the IOS team it is difficult to find new words to express our heartfelt appreciation to all those involved. Undoubtedly, chief scientist Marie Robert is at the core of this ongoing and successful program and we would like to say *merci* for her unwavering enthusiasm and generosity, as well as her incredible leadership. Our work was facilitated in so many ways by her experience and we are thankful for her presence and joyful personality. We wish to thank Michael Arychuk for his constant and tireless efforts with DMS analysis; once again it has been a real pleasure working with you. We are also truly thankful to Glenn Cooper for monitoring pH with keenness and flexibility during the subsampling period. Thanks to both watch leaders Moira Galbraith and Hugh Maclean for their patience and help during deck operations. A big thank you goes out to Darren Tuele for pre-cruise information about the incubators and to all IOS members involved in post-cruise analysis. We would also like to extend our sincere thanks to Captain Mike Corfield, boatswain John Gardner and the entire crew of the *CCGS John P. Tully* for their invaluable assistance and hard work. This trip was made enjoyable on many fronts, scientifically and socially, because of them. Last but not least, thank you to cook Bert Farwell and his acolytes for keeping us well fed and happy with an incredible variety of choices at every meal. Merci to all of you.

Robin Bénard and Martine Lizotte

PROJECTS AND RESULTS:

Water masses – Marie Robert, DFO/IOS.

The two main features on this cruise are first the very warm waters along line P. Figure 1 shows the difference between the temperature field in August 2013 and August 2012. Differences up to 6°C were present at the surface, but even deeper waters were warmer. The second feature is that the Pacific Ocean along Line P was very stratified, with a very shallow mixed layer depth, as can be seen in the sigma-t signal (Figure 2).

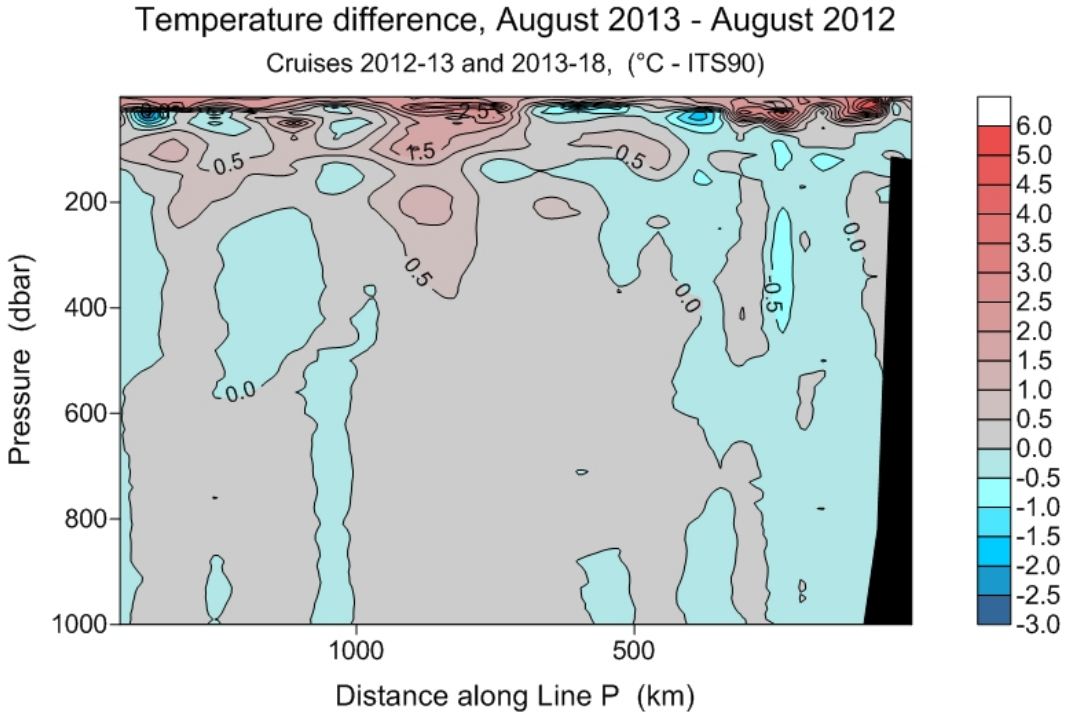


Figure 1: Difference in temperature between August 2013 and 2012. This year's waters were much warmer.

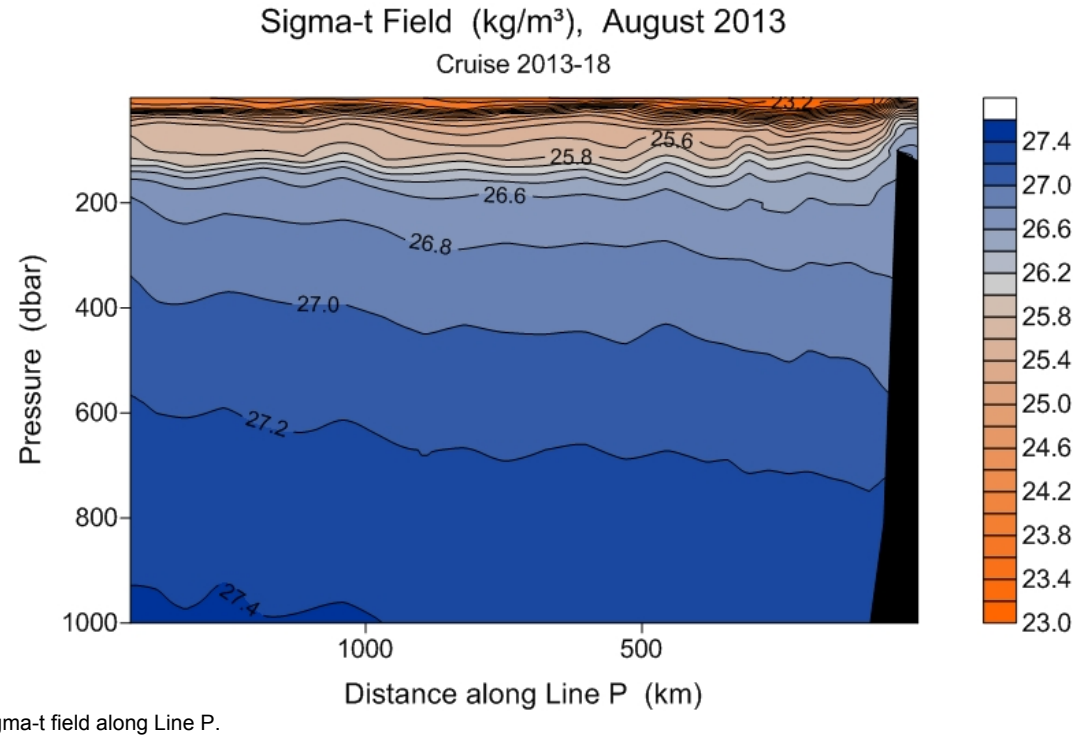


Figure 2: Sigma-t field along Line P.

Carbonate Studies: Glenn Cooper, Marie Robert and Mike Arychuk, DFO/IOS.

Four parameters of the carbonate system were measured on the 2013-18 mission. Both sea water pH and underway continuous automated pCO_2 were measured onboard the Tully. Samples for Total Inorganic Carbon (TIC) and Total Alkalinity (TA) were collected, preserved and returned to the Institute of Ocean Science (IOS) for further analysis.

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 into 10cm path length glass cuvette. Meta-cresol purple (mCP) was used as the indicator dye and was validated prior to the cruise at IOS. The following stations were sampled: P01, P02, P04, P12, P16, P20, and P26. A set of triplicate samples were taken at P02 station, whereas all other casts had two sets of triplicates which will be used to determine precision. Inter and intra Niskin calibration was performed at P23, whereby 5 Niskins were closed at 2000m and triplicates were analyzed from each Niskin.

Analysis of pH was provided to the incubation study, impacts of ocean acidification on DMS production, performed by Robin Bénard and Martine Lizotte from Université Laval. Initial pH of their starting experimental seawater (5 meter sample from P4) was determined using the salinity and temperature values obtained from the rosette CTD. Further analysis was carried out at day 0, day 3, day 6 and day 9 of the incubation study. Sample was drawn from each of the 3 control and each of the 6 experimental incubation bags directly into cuvettes. Incubation bath temperatures were collected at time of sampling. Experimental pH values were provided using both analysis and incubator temperatures.

2) Total Inorganic Carbon and Alkalinity Sampling:

Total inorganic carbon and alkalinity (TIC/Alk) samples were collected at P01, P02, P04, P12, P16, P20, and P26. One set of replicates was taken at each station. An entire extra set of samples was taken at P26 for archiving. Samples for inter and intra Niskin calibration were taken at 2000m from P23. Sea water was collected into 500ml glass bottles and overfilled with one and a half volumes. Samples were poisoned with 100 µl of saturated mercuric chloride. Bottles were sealed with greased glass ground stoppers and kept in place with electrical tape. Samples were stored at 4^{o}C until off loaded. We would like to thank Robin Bénard, Martine Lizotte and Andreas Mueller for assisting in poisoning, and sealing the samples.

Trace metal sampling–Christina Schallenberg, UVic; and NariSim, UBC.

The trace metal rosette (TMR) was deployed successfully at all major stations to a maximum depth of 2000m. The bosun and deck crew assisted with deployment and recovery as well as carrying of GO-Flo bottles, for which we are very grateful. Unlike for deployments on previous cruises, we opted to not have a counterweight hanging underneath the TMR, and this turned out to be a safe and good choice. Even in considerable swells, the crew managed to skillfully bring the TMR back on board without any incidents.

At P26, we also deployed GO-Flo bottles on the Kevlar line in the chains to a depth of 4000m. Again, all operations were successful. At all stations we had at least two TMR casts, often more than that, to allow for a depth resolution of up to 24 bottles.

The core TMR team consisted of Christina Schallenberg (deck operations and sampling), NariSim (control of the deck unit and sampling) and Maite Maldonado (deck operations and sampling). The team also got lots of sampling assistance from Nina Schuback, Carolyn Duckham, AniaPosacka, Ernesto Martinez, Hollie Johnson and Andreas Müller, and countless others helped carrying GO-Flos and operating the heave compensator.

Filtered (AcroPak 500 filter, 0.2 um) and unfiltered samples were taken from GO-Flo bottles into previously acid-cleaned LDPE bottles for later analysis in the lab. Samples collected from the TMR will be utilized by NariSim at UBC (dissolved Mn and Fe, particulate Mn and Fe), Christina Schallenberg at UVic (dissolved and particulate Fe), Kyle Simpson at IOS (dissolved and particulate Fe) and Dave Janssen at UVic (Cd isotopes). Kyle Simpson and the Cullen Lab at UVic will collaborate to analyze the collected Fe samples for total dissolved and total particulate Fe. Maintaining trace metal sampling along Line P is essential to understanding biogeochemical cycles, phytoplankton dynamics, and resulting effects to fisheries and the climate.

At up to 10 depths per station, 5-7 L of unfiltered seawater were collected from GO-Flo bottles to analyze suspended particulates of Mn and Fe. Samples collected in 10L cubitainers were filtered in the flow bench using membrane filters with two different pore sizes (7um & 0.45um). After the filtration, filters were collected in acid cleaned centrifuge tubes and stored at low temperature. Concentration of suspended particulates of Mn and Fe will be measured at UBC with HR-ICP-MS. NariSim will also analyze dissolved Mn and Fe in the filtered samples (AcroPak 500 filter, 0.2um) collected at major stations using isotope dilution method at UBC.

In addition to the above, Christina Schallenberg (UVic) measured Fe(II) at all major stations. The Fe(II) analysis was carried out at sea on unacidified samples employing the luminol method as described by Croot and Laan (2002). Filtered samples were drawn from GO-Flo bottles as soon as they were secured in the container and were analyzed within two minutes of filtration. Care was taken to maintain a stable light field in the flow bench during measurements as the luminol reagent was found to be extremely sensitive to changes in light intensity. Fe(II) profiles were measured down to a depth of 2000m.

The trace metal team would like to thank Marie Robert for being very accommodating with all the "special" TMR requests, the Tully's captain, officers and crew for safe operations and helping well beyond their "mandate", and all the scientists who contributed as "dirty hands", operators of the heave compensator, and GO-Flo carriers. You all helped making this a very successful trace metal cruise!

References:
P.L. Croot, P. Laan (2002). AnalyticaChimicaActa 466: 261-273.

Maldonado-Tortell Cruise Report, Line P, August cruise (2013-18)

We had two objectives:

1. To investigate copper bioavailability along Line P on: 1) mixed layer plankton communities, 2) microbial communities at the base of the mixed layer, and 3) the oxygen minimum zone. This work was done in collaboration with a) TRIUMF and Nordion Cyclotron facilities who provided the Cu^{67}, b) Steven Hallam lab (Sam and Andreas) sampling for cDNA in our incubations, c) Jay Cullen's lab sampling for dissolved Fe concentrations (as well as assisting with the TMR sampling, special thanks to Christina and Nari), and d) Kyle Simpson (IOS) for setting up the trace metal clean pumping system.

2. To investigate the extend of decoupling between the rates of primary productivity measured with carbon assimilation versus electron transport at PSII (ETR_{PSII}) – along a natural gradient of iron limitation, as well as an Fe addition incubation experiment at P20. This incubation experiment was in collaboration with Christina Schallenberg (Jay Cullen's lab).

Specific Goals:

1) <u>To investigate the response of an oceanic plankton community (top 200 m) to changes in Cu bioavailability</u>. Compared with other well studied bioactive trace metals (e.g. Fe, Zn), little is currently known about how oceanic populations respond to changes in Cu bioavailability. Given the potential for Cu limitation and toxicity in open ocean waters, we performed two 6-day bottle incubation experiments with water collected from the mixed layer and from 200 m at P16. We examine the plankton response to a gradient of Cu availability from potential Cu toxicity (10 nM Cu added) to Cu limitation (30 nMCyclam added; a strong Cu-ligand that decreases Cu availability). We chose P16 as the test station to allow enough time for the communities to respond. We monitored phytoplankton and bacterial biomass, growth (gross and net primary productivity, as well as bacterial productivity), intracellular Cu:C assimilation ratios, short-term Cu uptake rates, photosynthetic competency (FRRF) and species composition (HPLC pigments, flow cytometry and microscopy). We also sampled for dissolved Cu, Fe and Cu speciation.

2) <u>To probe the effects of changing Cu availability on microbial communities in the core of the oxygen minimum zone (OMZ) at the coastal station P4</u>. Copper is involved in many microbial processes including organic matter processing, and production/consumption of greenhouse gasses, such as nitrous oxide and methane. We performed one incubation experiment, using gas tight bags, using water from 1000m (collected with the TMR) at P4. In addition, we also incubated communities

sampled from the thermocline (200m) at P16. The incubation from P4 is on-going (we will take the bags back to UBC and keep sampling in the coming month). The incubation at P16 was 9 days, and we monitored the changes in bacterial biomass and productivity, gasses (N_20 and CH_4), organic matter consumption, Cu acquisition, and microbial community structure (using flow cytometry and cDNA).

3. To investigate the extend of decoupling between the rates of primary productivity measured with carbon assimilation versus electron transport at PSII (ETR_{PSII}) as a function of Fe availability. The extent of decoupling can be related back to phytoplankton community composition and external environmental variables. This will give insight into the photophysiology of field phytoplankton assemblages and how photosynthesis and primary productivity is affected by the environment. Further, it allows to derive a conversion factor to convert rates of ETR_{PSII}, which can be acquired in high spatial and temporal resolution, to ecologically relevant rates of carbon assimilation.

    a) For the in situ measurements, samples were taken from the rosette at three depth (5m, chlorophyll max, mid mixed layer) at all five major stations (P4, P12, P16, P20, P26). From each of these points samples were collected for flow cytometry (triplicate), HPLC (duplicate), [chl-a] (duplicate), absorption coefficients and absorption spectra (duplicate). Further, water from each depth at each station was used to perform ^{14}C-assimilation experiments (10 light level light response curves, 4 hour incubation time) and to acquire data on the FRRF (10 light level rapid light curves, ETR_{PSII}, Fv/Fm, functional absorption cross sections, PQ pool size). Furthermore, the FiRe was connected to the underway sampling system to log underway data of Fv/Fm and functional absorption cross section.
    Unfortunately, the MIMS was not running for this cruise, but it will stay on the Tully for the LaPerouse cruise and hopefully be up and running for it.
    Water was collected from the underway sampling system and at P4 to isolate cyanobacteria using a sorting flow cytometer at UBC.

    b) For the Fe incubation experiments at P20, a similar approach was taken. Iron was added as $FeCl_3$, as well as dust.

Acknowledgements
Our group would like to thank Marie Robert for all her help and patients while preparing for and during this cruise. Our group had a lot planned for this cruise and we got a lot of help from everyone, which we appreciate a lot! Thank you for providing all the extra lab, fridge and freezer space and the use of the pump. Also, special thanks making sure Nina's Light Cast always happened at the right time of the day. Very special thanks also goes to Mike Arychuck, who made it possible for all of us to work in the rad van and to get our radioisotopes to IOS. We would also like to thank Melanie and Kyle for helping us with all our radioisotope requests. Thanks also goes to Mike for help with receiving gasses for the MIMS and the liquid nitrogen for our group. Also a big thanks to Hugh MacLean for his patience during the pumping sampling, the watches, and his big smiles at all times.

Sam Kheirandish and Andreas Mueller UBC Line P – June 2013

Objectives:
Describe the taxonomic and metabolic diversity of the bacterial community in the cycling of major nutrients and gasses along the Line P, focusing on the communities in the Oxygen Minimum Zone.

Sampling summery:
At 5 Stations (P4, P12, P16, P20 and P26)

1) Gasses samples were taken for later dissolved nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), Argon (Ar) and nitrous oxide (N_2O) measurement using Chromatography Mass Spectrometry
2) 10 ml seawater samples were taken per depth to count the numbers of cell per milliliter using Flow Assisted Cytometry
3) 10 ml seawater samples were taken for hydrogen sulfide (H_2S) quantification
4) 2 L seawater samples (at 16 depth) for high resolution bacterial DNA and sequencing were filtered
5) For single cell DNA analysis, samples were taken and preserved using *glyTE*

Additionally, at 3 major stations (P4, P12 and P26) the following were sampled at four depths across the oxygen minimum zone

1) Large volumes (20 L) per depth were filtered to create genomic libraries of the bacterial communities
2) After adding of iron chloride to the filtered water, the samples were filtered again for later virus analysis
3) Samples were taken and preserved using *DMSO* to use for Flow Cytometry analysis
4) For virus counting, samples were taken and preserved using *glutaraldehyde*
5) Gasses samples were taken for later dissolved nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), Argon (Ar) and nitrous oxide (N_2O) measurement using Chromatography Mass Spectrometry
6) 10 ml seawater samples were taken per depth to count the numbers of cell per milliliter using Flow Assisted Cytometry
7) 10 ml seawater samples were taken for hydrogen sulfide (H_2S) quantification
8) For single cell DNA analysis, samples were taken and preserved using *glyTE*
9) Additionally, water was taken for salinity and nutrient analysis
10) For P26 seawater samples were taken, preserved using *formaldehyde* and were filtered for FISH analysis

Comments:
We really appreciated the time on board with the crew, officers and scientist to explain their work to us. The cruise gave us the opportunity to learn more about of the work of the scientist and the environment of the Pacific Ocean.

All our lab objectives for this cruise were successfully fulfilled. The work area distribution was very convenient for our sampling needs and we will try to use the same setup once again in future cruises.

Gas samples were taken, in duplicates at all depths at stations P4, P12, P16, P20 and P26. Additionally, gas samples were also taken in duplicate at the 4 UBC depths at P4, P12 and P26.

We wish to thank the Tully crew for their assistance and excellent work throughout the cruise. Thanks to Marie Robert and the scientists onboard for their help on deck and in the lab.

Zooplankton sampling: Moira Galbraith, DFO/IOS.

One shallow (250m) and one deep (1200m) bongo sample were collected at each major station except P02 with only one shallow tow and P26 where an additional 2000m sample was added giving a total of 14 frozen and formalin preserved samples.
Tully crew supplied rubber matting for the bongo landing area plus weights which greatly helped in reducing wear and tear on the equipment on deployment and retrieval, much appreciated. The bongo winch still suffers from slack wire during heaving but the more forward placement of the winch keeps the wire from hitting the deck. Deck crew did an excellent job of handling the idiosyncrasies of the bongo winch and bridge were great at dancing the ship to keep wire vertical, again much appreciated.

Micro-plastics:
3 sieve samples (0.25mm, 0.125mm, 0.0625mm) from 10 sites along Line P; collected on the shelf, shelf break, offshore and station P26 for a total of 30. Sampling was done through the loop system in the lab which ran into problems throughout the trip. First was the new flow design, developed by Scott, which did not quite work as there was no way to remove air trapped high in the system. This problem was solved by the Engineering Department which were kept very busy throughout the trip fighting with pump failures, bubbling issues and heavy demand for seawater. TSG data will probably be questionable. There seemed to a lot gelatinous particulates coming through the system which may be hydromedusae budding off the hydroid colonies growing within the pipes. There were also a lot of barnacle exoskeleton plus mussel shells and byssal threads (attachment hairs). A good flushing of the whole system may be necessary.

CTD Closet:
Computer still crashing for no apparent reason, perhaps it is time to get a more stable, robust system; Apple comes to mind. It would be a great help to have the depth/altimeter monitor placed above/near the CTD monitor rather than its present location which requires a lot of neck twisting, head craning and getting out the seat to view the screen clearly, not to mention it obscures the navigation monitor.

2013-18 Cruise Report

Hollie Johnson, Research Assistant
Gas Tracers Lab (PI: Dr. Roberta Hamme), Department of Earth of Ocean Sciences, University of Victoria

Careful analysis of dissolved gases in the ocean can reveal quantitative information about underlying physical and biological processes, and give insight into water mass formation and movement. To investigate these processes, five types of samples were collected on this cruise: ONAr, dissolved oxygen, Noble gas, ^{17}O, and salinity samples.

ONAr and dissolved oxygen: Samples were collected in duplicate from surface to near-bottom depths at stations P4, P8, P12, P16, P20, and P26. At the mooring, station PA-007, samples were taken in the top 10m. The majority of ONAr samples collected on this cruise will be analyzed at the University of Victoria to obtain precise measurements of O_2/N_2, N_2/Ar, and O_2/Ar, and will be used to investigate production along Line P as well as the origin of N_2 at mid-depths. At the mooring, ONAr samples were collected on behalf of Steve Emerson at the University of Washington. Results will be used to calibrate instruments on the mooring. Dissolved oxygen samples were analyzed on board using the Winkler titration method with a visual endpoint.

Noble Gas: Collected in duplicate at stations P2, P4, P8, P12, P16, P20, and P26. Noble gas samples will be analyzed at the University of Victoria to give precise measurements of Xe, Ne, Kr, and Ar saturations.

^{17}O: Samples were collected in the top 200m at P26 on behalf of Paul Quay at the University of Washington, where they will be analyzed.

Salinity samples were collected alongside ONAr, Noble Gas, and ^{17}O samples. Salinity is an important parameter used in determining gas solubilities. Samples will kindly be analyzed at IOS.

Acknowledgements: Thank you to the Captain and the Red Crew of the J.P. Tully and to IOS personnel Marie Robert, Hugh Maclean, and Moira Galbraith. Thank you all for working together so well. Your exceptional planning, organization, and collaboration made this research cruise successful. We appreciate all of the hours spent operating the winch, spent in the closet communicating with the rosette, working behind the scenes to keep operations running smoothly, working to keep us square on station, and scheduling in our sampling requests. Many thanks to the cook, Bert Farwell, for preparing so many delicious and healthy meals and for being so accommodating to dietary constraints. We would like to thank IOS for providing salinity sampling bottles and performing analysis of salinity samples. Thanks everyone!

August 2013 Line P Cruise Report: Robin Bénard, Martine Lizotte, and Maurice Levasseur
Université Laval, Québec City, Qc, Canada

Biogeochemical Impacts of Ocean Acidification on a Coastal Plankton Community of the Subarctic Pacific and the Production of Climate Active Gases – Nitrous Oxide and Dimethylsulfide

1. Why we participated? – The rationale and objective

As anthropogenic emissions of carbon dioxide (CO_2) into the atmosphere have increased, so has the uptake of CO_2 by the oceans. Now recognized as the "other CO_2 problem", this increased transfer of CO_2 has led to the acidification of oceans. Waters off the West coast of the North American continent are particularly sensitive to pH modifications as they are influenced by the concomitant upwelling of poorly oxygenated water rich in CO_2 entrained through the Juan de Fuca gyre leading to a potentially premature exposure of the coastal communities to ocean acidification. Marine communities are highly sensitive to modifications of pH, particularly species that rely on calcification to live such as Coccolithophorids. These phytoplankters are prolific producers of dimethylsulfoniopropionate (DMSP), the precursor of the climate-cooling gas dimethylsulfide (DMS). The central objective of this project is to determine the impact of ocean acidification on a coastal planktonic community of the North Pacific and its production of climate active gases such as DMS and nitrous oxide (N_2O), a biogenic greenhouse gas prevalent in hypoxic waters.

2. What we did? – The methods

Approximately 250 litres of water was collected before sunrise at Station P4 by pumping water at 5m depth with a teflon diaphragm pump. Samples were collected directly in medical grade 20-l Labtainer^{TM} collapsible bags for incubation. Water samples were subjected to the treatments (in triplicate) shown in Table 1 and allowed to equilibrate for 24-h before the start of the incubation period. The incubation bags were hermetically sealed and

incubated during 11 days in outdoor incubators at *in situ* temperature and attenuated irradiance on the helicopter deck of the *CCGS* John P. Tully. Measurements of incubator water temperature and ambient photosynthetic active radiation (PAR) were recorded daily. Concentrations of DMS were measured every day while the following variables were monitored at T0, T2, T4, T6, T8 and T10: primary productivity (^{14}C-labelled 24-h incubations), chlorophyll *a* (chl*a*) concentrations, nutrients, phytoplankton enumeration, virus and bacterial enumeration, total and dissolved dimethylsulfoniopropionate ($DMSP_t$ and $DMSP_d$) concentration and N_2O concentrations. Samples of pH, dissolved inorganic carbon (DIC), alkalinity and salinity were taken at T0, T3, T6 and T9, while samples for phytoplankton identification by high purity liquid chromatography (HPLC) were taken at T0, T4 and T10.

Table 1. Identification of the treatments used during an 11d incubation experiment focused on the impact of ocean acidification on the production of DMS and N_2O.

Identification	**Treatment**
Control (C)	No addition
Treatment 1 (A)	pH reduction of 0.2 unit
Treatment 2 (B)	pH reduction of 0.4 unit

Samples of DMS, pH and chl*a* were analyzed onboard the ship within hours of collection. Primary productivity, DIC, alkalinity, salinity, nutrients, and HPLC will be analyzed at the Institute of Ocean Sciences. The remaining samples ($DMSP_t$, $DMSP_d$, N_2O, virus-bacteria-phytoplankton cytometry) will be brought back to Laval University in Quebec City for analysis.

Overall, experiments conducted during this cruise met with success. The only potential problem occurred early on during pumping of the incubation water. The diaphragm pump used operates in sharp pulses which we think may have caused plankton cell damage and lysis as well as gas ventilation in the early stages of the incubation period. Evidence of this was thought to be seen in highly variable DMS concentrations within triplicates of a same treatment. We recommend the use of Niskin bottle sampling and water pooling for further experimentation and investigation of marine biogenic gases. The work area provided in the main lab was highly appreciated and met all our requirements in terms of surface and accessibility. Despite the expected affluence within the radvan, schedules and number of maximum occupancy by participants was very well respected. We do however suggest a slight reorganization of the gear and more specifically of the fume and laminar hood placement. Having two hoods in front of each other made dual usage by participants a challenge. Simply moving the starboard laminar hood slightly further from the fixed portside fume hood would alleviate any difficulties in the future.

3. What we want to convey? – The acknowledgements

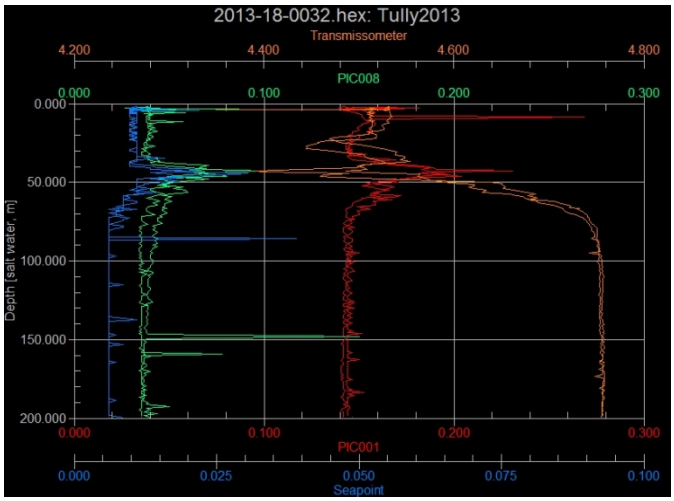
After 7 years of close collaboration with the IOS team it is difficult to find new words to express our heartfelt appreciation to all those involved. Undoubtedly, chief scientist Marie Robert is at the core of this ongoing and successful program and we would like to say *merci* for her unwavering enthusiasm and generosity, as well as her incredible leadership. Our work was facilitated in so many ways by her experience and we are thankful for her presence and joyful personality. We wish to thank Michael Arychuk for his constant and tireless efforts with DMS analysis; once again it has been a real pleasure working with you. We are also truly thankful to Glenn Cooper for monitoring pH with keenness and flexibility during the subsampling period. Thanks to both watch leaders Moira Galbraith and Hugh Maclean for their patience and help during deck operations. A big thank you goes out to Darren Tuele for pre-cruise information about the incubators and to all IOS members involved in post-cruise analysis. We would also like to extend our sincere thanks to Captain Mike Corfield, boatswain John Gardner and the entire crew of the *CCGS John P. Tully* for their invaluable assistance and hard work. This trip was made enjoyable on many fronts, scientifically and socially, because of them. Last but not least, thank you to cook Bert Farwell and his acolytes for keeping us well fed and happy with an incredible variety of choices at every meal. Merci to all of you.

PIC SENSING: Ernesto Martinez, University of California, Berkeley.

Objective: The goal of this project was to measure the Particulate Inorganic Carbon (PIC) content of the North Pacific Ocean along Line P. These observations will be used to calibrate two PIC sensors (PIC 001, an analog sensor and PIC008, a digital sensor) designed by James Bishop (University of California, Berkeley), which are currently in the final stages of development.

The PIC sensors measure calcium carbonate ($CaCO_3$), which is mainly formed by coccolithophores. These phytoplankton use$CaCO_3$ to make protective casings. Thus, $CaCO_3$ forms in areas of high productivity. Much of this particulate carbon is ultimately lithified on the ocean floor, making it an important carbon sink. The sensors use a polarized laser and a cross polarized receiver. When calcium carbonate enters the beam path, it changes the plane of polarization, and the signal increases. The two sensors were mounted on the Rosette from the start of the cruise until P16. Before any P16 cast, PIC001 was removed from the rosette system, and was replaced by a transmissometer. Profiles were taken all along P, with results consistent with measurements taken by remote sensing. At major stations, 1 liter water samples were collected. These samples were filtered using a small volume direct filtration system, and the Supor membrane disc filters were saved for later analysis.

Below is an example of a PIC profile. This profile is from station P12. The red line shows the PIC sensor reading from the analog sensor, PIC001. The green line indicates the PIC sensor reading from the digital sensor, PIC008. The spikes are most likely caused by large organisms, but the trend shows high levels of PIC, especially near the surface, as is expected.



A small drift in the upper layer indicating a thermal lag is detectable in PIC001. The sensor reaches very low temperatures at the near the ocean floor, as it warms in the mixed layer, it causes the measurements to drift. Further work is needed to properly correct for the hysteresis that this causes. PIC008 observations during the CTD upcast, however, closely mirror downcast measurements.