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:** 16 August 2011 **TO:** 1 September 2011

SCIENCE CRUISE NUMBER: 2011-27 **SHIP'S PATROL NUMBER:** 11-06

CHIEF SCIENTIST[S]: Marie Robert

SCIENTIFIC PERSONNEL:

Female	Male
Lizzy Asher (UBC)	Michael Arychuk (IOS)
Moira Galbraith (IOS)	Jason McAlister (UBC)
Diane Perry (UW)	Craig Mewis (UBC)
Ania Posacka (UBC)	Scott Rose (IOS)
Wendy Richardson (IOS)	David Semeniuk (UBC)
Marie Robert (IOS)	Kyle Simpson (IOS)
Christina Schallenberg (UVic)	
Nari Sim (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.

This cruise (2011-27) was 100% successful. All stations were visited and all casts were done. This was the first time that both the DMS container and the Trace Metal container were set up on the aft-deck, and it worked really well. It definitely makes work easier to have the Trace Metal rosette and container on board than having to use the X-Niskins on the hydro-winch and have to set-up many "bubbles" in the main lab for sampling. Since most August cruises are "trace metal cruises" it is very good to see that the new set-up worked so well.

CRUISE OBJECTIVE/OBJECTIVES: Repeat hydrography section. Deploy one Argo float for IOS and one weather data drifting buoy for Environment Canada. Do intensive sampling for Trace Metal studies.

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

DAYS LOST DUE TO WEATHER: None. Just had to slow down somewhat.

SAMPLING:

- The Line P survey was 100% successful. All stations were sampled in order and all casts were done.
- One Argo float was deployed for DFO/IOS at P14.
- The set-up of the Trace Metal Rosette on the aft-deck and the IOS Rosette at the mid-ship station worked beautifully. This is yet one more example of the usefulness of the mid-ship station.
- The samples collected include:

  1) Underway: **IOS**: Thermosalinograph (Temperature, Salinity, Fluorescence), pCO_2, acoustic sounder.

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

  3) From the Rosette: **IOS:** dissolved oxygen, salinity, nutrients, chlorophyll, HPLC, DIC, Alk, DMS, DMSP-p, DMSP-t, pH, DOC (for U. Miami) – **UBC (Mewis, Asher):** dissolved nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), argon (Ar), nitrous oxide (N_2O), number of cells per millilitre, bacterial genomic (DNA, RNA), Methane, DMSO, DMSOp – **UW (Perry):** Oxygen, ONAr (Oxygen, Nitrogen, Argon), salinity, DIC, DOC

  4) From the pump/Trace Metal Rosette: **IOS (Simpson):** Iron (Dissolved and Total dissolved, three different treatments) – **U Victoria (Schallenberg):** iron II ; **UBC (Semeniuk, Posacka, McAlister,Sim):** Cu total, Cu dissolved, Copper ligands, chlorophyll *a*, nutrients, salinity, HPLC, POC, PON, POS, DMSP, DMSO, Cu:C assimilation ratios, Primary productivity, bacterial productivity, bacterial biomass, copper uptake.

  5) **IOS (Galbraith):** Zooplankton using vertical net hauls.

RADIOISOTOPE USE:

The following radioisotopes were used in the Rad-Van: ^{3}H-thymidine (aqueous), ^{55}Fe chloride, ^{14}C-bicarbonate, ^{14}C-leucine (aqueous), and ^{67}Cu-chloride. Wipe tests were done in all appropriate areas of the ship upon completion of the studies and the lab was decommissioned at the end of the cruise.

PROBLEMS [SCIENTIFIC GEAR AND OPERATIONS]:

The two laptops we received from the Water Properties group to print the labels were not set-up properly. One did not have the labelling program on it, and is painfully slow (should be retired), and the other one did not have the printer driver on it. "Label laptops" should have both the appropriate program and drivers on them.

Something must be done about the "this is not my gear" mentality that seems to be the norm with everyone on loading/offloading day. People have to understand that helping each other makes loading/offloading go much faster.

We had a few mis-trips of the IOS rosette at the beginning of the cruise. Thanks to Scott for changing pylon and latching mechanism.

Many black caps were missing for the salinity bottles (~ 100).

There was a problem with the GPS signal going to the Thermosalinograph (TSG): at 49°23.29N, 136°02.34W on the return leg the position in the TSG stopped updating.

Oxygen: first off, I would like to thank Nina for taking the time to teach me the ins and outs of the oxygen system and for coming down to the Tully to help set up the system. Over all I would say that the system operated fairly well except for some problems at the start of each day between the program, ports and computer. I have made Steve Romaine aware of the nature of the problems and suggested the need to have someone knowledgeable to fix/repair/program the system. Each watch drawing the oxygen's did a good job on minimizing sampling mistakes such as bubbles, shaking, storage or adding milli-Q to the tops. Viewing the process from bottle to sample processing, the write in the rain paper for the rosette sheets is the only way to go.

Moira Galbraith

SUCCESSES [SCIENTIFIC]:

Once again the new CTD and CTD computer worked without a glitch.

The science team was asked by the Tully crew to make a short presentation about the work we do on board, and why we do some things the way we do (for example all the care taken around the Trace Metal rosette). It was a really fun thing to do, and the Trace Metal gang managed to build a very good story in the little time we had to prepare. Thanks to Jason for taking the lead in this; you did an awesome job!

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

The hydro winch spooling gear was not fixed from the June cruise problems.

We were told that there would potentially be two cadets on board for this cruise. By the time we learnt that no cadets would be present, we started the security clearance for a scientist who was on the waiting list. But the notice came too late and the security clearance could not be obtained on time. It would be good if we had a longer warning of how many berths are available for each cruise.

SUCCESSES [SHIP]:

The AVOS system did not have to be reset during the whole cruise (it needed almost daily resets in June).

DELAYS [OTHER THAN WEATHER]:

None.

SAFETY CONCERNS:

None.

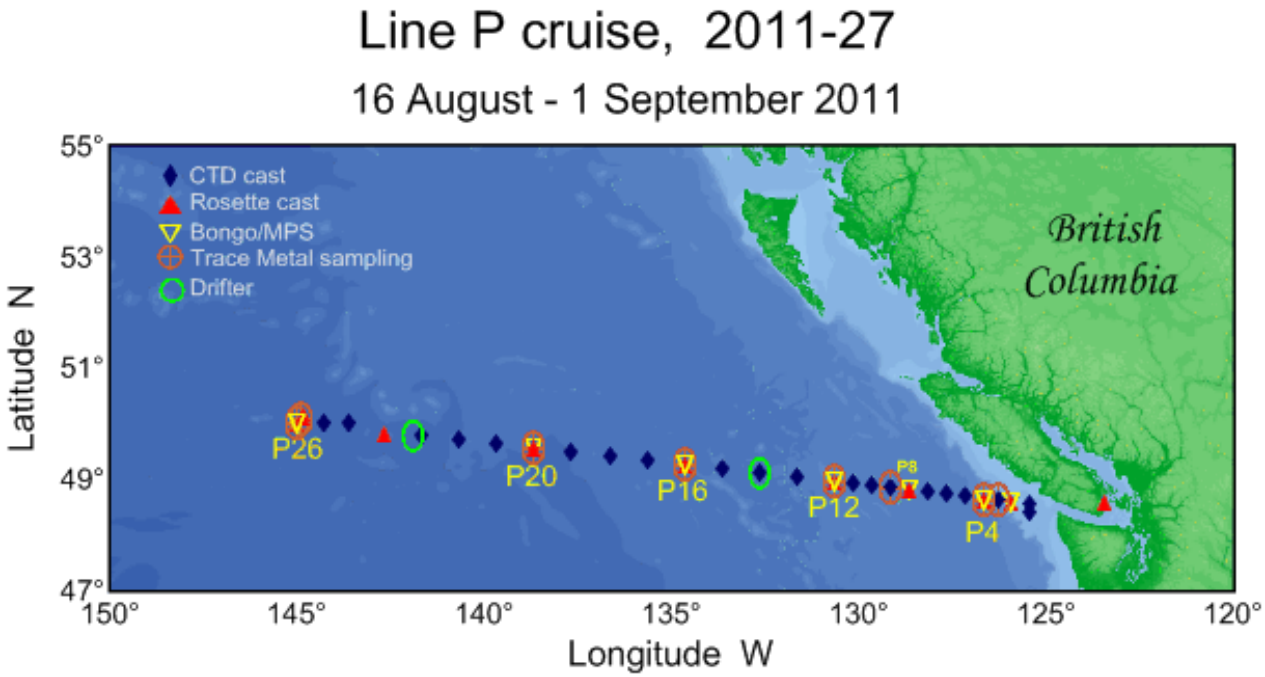
HAZARDOUS OCCURRENCES:

None involving science personnel.

EVENT LOG:

DATE		OPERATIONS
Tuesday	**16 Aug:**	**Start loading the ship at IOS around 1400.**
Wednesday	**17 Aug:**	**Keep loading/setting up in the morning. Leave IOS after lunch.**
		Do the Saanich Inlet cast, leave for P1 around 1430.
Thursday	**18 Aug:**	**Station P2 and start station P4.**
Saturday	**20 Aug:**	**Start Station P12, stay for 15.5 hours.**
Monday	**22 Aug:**	**Station P16 for 14 hours.**
Tuesday	**23 Aug:**	**Start Station P20 for 16.5 hours.**
Friday	**26 Aug:**	**Arrive at Station Papa during the night.**
Saturday	**27 Aug:**	**Complete Station P. Burial at sea ceremony, then depart to Pat Bay.**
Wednesday	**31 Aug:**	**Arrive at IOS and start offloading.**
Thursday	**1 Sep:**	**Complete offloading in the morning.**

CRUISE TRACK:



SUMMARY/FINAL COMMENTS:

- We would like to thank everyone on board for such great help. As usual, help was always provided with a smile from all departments.
- Many thanks to everyone at IOS who have helped make this cruise a success: Janet, Nina, Melissa … your help is always greatly appreciated!
- Finally, a very special thank you to Moira for agreeing to sail with us to Station Papa with such short notice and with a sore shoulder! Moira you saved the cruise! ☺

Marie Robert and the science team.

- I would like to thank Nina for taking the time to teach me the ins and outs of the oxygen system and for coming down to the Tully to help set up the system.
- I would like to thank my personal assistants: Dave, Jessie, Zach and Conor; who helped me with every bongo deployment and retrieval; really appreciated. Big thank you to the rest of the crew of the Tully for making this program a big success.

Moira Galbraith

- Overall, the cruise was a great success for our group. We would like to thank IOS, Marie Robert, and the officers and crew for their logistical support throughout the cruise. We look forward to our next cruise!

David Semeniuk and Ania Posacka

- Deployment of the Trace Metal Rosette (TMR) was challenging, but made possible by the helpful effort of the bosun, Mike, and deckhands Jesse B, Jesse F, Zach, Lawrence, Dave, and Connor. The deckhands were all very cooperative wearing gloves and were cautious of the Kevlar line touching the deck.
- Chief Engineer Roger and Vaughn were able to quickly solve an electrical issue with the winch.
- Lastly, many thanks to the captain and crew of the CCGS Tully and to the Chief scientist, Marie Robert: without their hard work and cooperation this work would not have been possible.

The Trace Metal Gang.

PROJECTS AND RESULTS:

Water masses. Marie Robert, DFO/IOS.

In June 2011 the surface waters were colder than the long term average (1956 – 1991) along Line P, with anomalies higher than -1.0°C in the more coastal regions (P9 – P16). There was a pool of warmer waters between 70 and about 300 m from P18 to P25 (Fig. 1). By August the surface waters had warmed up enough that they were actually warmer than the long term averages for that month. The pool of warmer waters around the offshore stations was still present (Fig. 2). The summer coastal upwelling is visible in the isopycnals (Fig. 3).

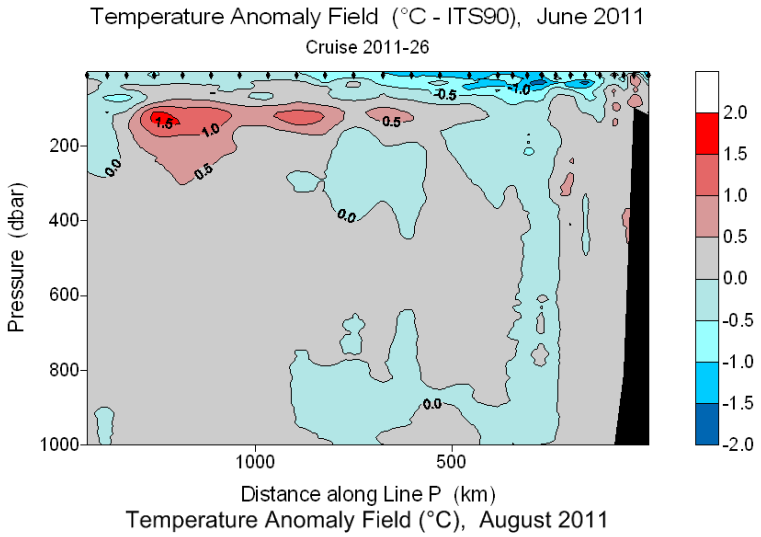


Figure 1: Temperature anomaly field (°C) in June 2011 with respect to the 1956-1991 average.

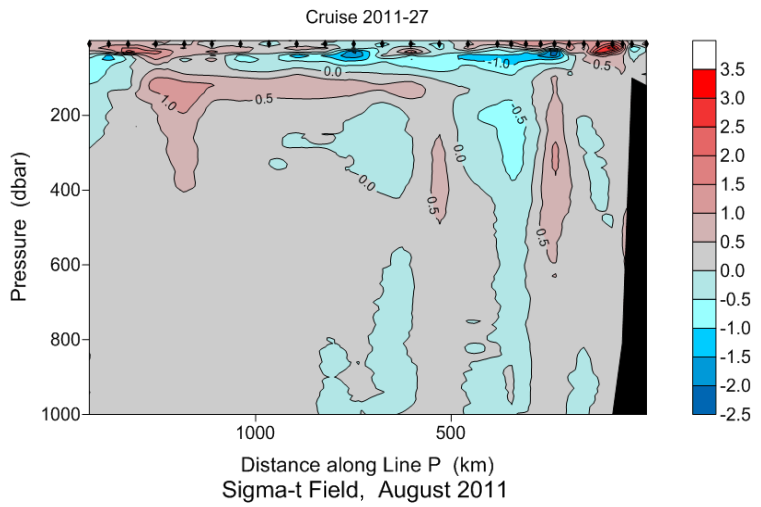


Figure 2: Temperature anomaly field (°C) in August 2011 with respect to the 1956-1991 average.

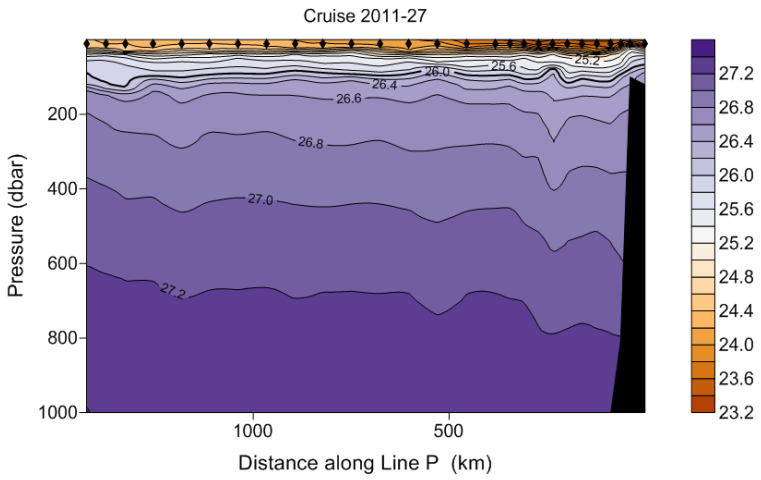


Figure 3: Sigma-t field in August 2011 along Line P. The isopycnals near the coast illustrate the seasonal upwelling.

Zooplankton study – Moira Galbraith, DFO/IOS.

The aim of the August zooplankton survey along Line P was twofold: routine monitoring as part of a long-term, valuable time series and to ascertain if the three Neocalanus species had gone into diapause. To this end, I was able to achieve all samples planned for: one shallow 250m and one deep 1200m bongo sample for each major station along Line P. I also would like to apologize, again, for taking up wire time at P8 to get the 1200m tow in but, in hindsight, it may be the most interesting sample from a species diversity point of view. At P26, there was enough time to get 4 samples: 250m, 500m, 1000m and 1200m. The only glitch in the set up was when the propeller for the TSK flowmeter fell out sometime between steaming from P20 to P26. Normally these flowmeters are quite robust and indestructible so I am not sure what happen to make it fail but I suspect ship vibration. Placing the bongos on a rubber mat seemed to dampen the vibrations plus prevent the nets from getting cut when the metal collars would fall over in a swell or deployment. I am definitely going to recommend using a rubber mat or pallet for all future cruises doing bongo sampling. The placement of the bongo winch on the starboard aft deck kept the wire up off the deck in heavy seas and there is a bit more space at the gate to pass the weight through than on the port side. I understand though that it is in the way for loading/offloading of gear.

I would like to thank my personal assistants: Dave, Jessie, Zach and Conor; who helped me with every bongo deployment and retrieval; really appreciated. Big thank you to the rest of the crew of the Tully for making this program a big success.

Iron II measurements – Christina Schallenberg, University of Victoria.

Christina Schallenberg (UVic) measured Fe(II) during the cruise at three stations: P16, P20 and P26. The Fe(II) analysis was carried out at sea on acidified samples employing the luminol method. All samples were filtered with an AcroPak 500 filter (0.2 um) prior to measurement. Fe(II) profiles were measured down to a depth of 2000 m. At Station P26, Christina was also able to compare measurements of Fe(II) from GoFlo bottles with measurements obtained from the trace metal pump – a very valuable comparison considering the fast oxidation rate of Fe(II) in surface waters.

Trace Metal Physiology Team – David Semeniuk & Ania Posacka (Maldonado Group, UBC).

Objectives: our aims were three-fold on this cruise: a) to elucidate the physical, chemical, and biological controls on the intracellular copper (Cu) requirements and Cu uptake rates of marine microorganisms along Line P; b) to investigate the response of an oceanic microorganism community to changes in Cu bioavailability in a bottle incubation; and c) to investigate how marine microorganisms can affect the chemical speciation of Cu in seawater.

Our work was done in collaboration with TRIUMF who provided the Cu67, Lizzy Asher (UBC) who measured DMSO and DMSP in our incubation, the TMR team (UVic/UBC) for providing seawater at a number of stations, and Kyle Simpson (IOS) for setting up and assisting with the trace metal clean pumping system.

Specific Goals:

1) To elucidate the physical, chemical, and biological controls of the intracellular copper requirements and uptake rates of marine microorganisms along Line P. While Cu is an important nutrient required in trace amounts by marine microorganisms, it can be toxic at elevated concentrations. Although early workers observed that only inorganic forms of Cu were directly available for uptake by phytoplankton, recent laboratory studies by our research group and fieldwork along Line P have demonstrated that organically bound Cu is also bioavailable. Furthermore, we observed that the *in situ* organically bound Cu in seawater was being directly acquired at P26 during cruises in 2006 and 2008. Given these novel results and potentially important role that Cu plays in mediating the growth of marine microorganisms, it was our goal to determine how a suite of physical (light), chemical (Cu concentration and speciation), and biological (biomass, growth, species composition, photosynthetic competency, particulate S-containing compounds) factors may control (or correlate with) the *in situ* intracellular Cu requirements and short-term Cu uptake rates of marine microorganisms along the Line P transect (2 to 3 depths per station; stations P4, P12, P16, and P26) using the carrier free radioisotope Cu67.

2) To investigate the response of an oceanic microorganism community to changes in Cu bioavailability in a bottle incubation. Compared with other well studied bioactive trace metals (e.g. Fe, Zn), little is currently known about how oceanic populations of marine microorganisms respond to changes in Cu bioavailability. Given the potential for Cu limitation and toxicity in open ocean waters, we performed a 4-day bottle incubation with water collected from the surface at P16 in order to examine how open ocean phytoplankton respond to a gradient of Cu bioavailability. We included five treatments ranging from potential Cu toxicity (10nM added Cu) to Cu-limitation (30nM added Cyclam, a strong Cu-ligand that makes Cu less available than the *in situ* Cu ligands), and monitored phytoplankton and bacterial biomass, growth, intracellular Cu:C assimilation ratios, photosynthetic competency, species composition, and particulate DMSO and DMSP over the course of the incubation.

3) To investigate how marine microorganisms can affect the chemical speciation of Cu in seawater. The speciation of dissolved Cu in seawater is dominated by strong organic complexes that have traditionally been thought detoxify Cu. However, it remains uncertain whether the strong Cu ligands in seawater are the result of active production and exudation by marine microorganisms, or the result of cell lysis or death. Furthermore, our work at P26 in previous years has demonstrated that Cu bound to the in situ ligands is bioavailable. As such, the role and origin of strong Cu ligands play in seawater (i.e. to detoxify Cu or facilitate Cu uptake) remains contentious. It was our goal to determine how marine phytoplankton and bacteria affect Cu speciation when exposed to toxic levels of Cu and during the remineralization of dying phytoplankton. We collected water at the surface of P8 and subjected the *in situ* microorganism community to toxic Cu concentrations (0-100nM stepwise), and monitored Cu speciation, phytoplankton and bacterial biomass, and Fv/Fm over 36h compared to a control treatment. To determine if dying phytoplankton could be a source of strong Cu ligands to seawater, we included a dark treatment that was sampled 10 days later.

Overall, the cruise was a great success for our group. We would like to thank IOS, Marie Robert, and the officers and crew for their logistical support throughout the cruise. We look forward to our next cruise!

Line P cruise report – Lizzy Asher, University of British Columbia

Dimethyl Sulfide (DMS) concentrations in the northeast pacific are higher than 95% global measurements and exhibit considerable spatial variability. My PhD thesis work this trip involved studying the relationship between spatial variability of DMS concentrations in the northeast Pacific and its production and consumption rates in the context of biological and hydrographic parameters.

Using a new method developed in collaboration with John Dacey from Woods Hole Oceanographic Institute, I used stable isotope methylated sulfur compounds (dueterated D-3 DMS, C-13 labeled dimethyl sulfoxide (DMSO) and deuterated D-6 dimethyl sulfoniopropionate (DMSP) with the mass to charge ratios of 65, 80 and 221 respectively) as tracers to calculate rates of DMSP cleavage and DMSO reduction, which are both sources of DMS production, and DMS consumption of these naturally occurring compounds in the surface ocean at major stations along the line P transect.

At P26, water from 10m, 20, 40m was sampled and incubated at in situ light levels using neutral density screening to study the impact of light on DMS turnover rates. To determine the abiotic rate processes at work, samples from 10m, 20m and 40m at P26 were filtered through 0.2um filter and incubated at these light levels. Water from P12 was also sampled, enriched with 1μM of DMS, DMSO, and Dimethyl sulfone ($DMSO_2$), and incubated for multiple days at ~10% light. Daily samples of DMS and DMSO were collected and analyzed to study the maximum turnover of these compounds. After 10 days, 6-7L (the remaining sample volume) was pre-filtered using GFD filters to remove eukaryote DNA, and subsequently filtered onto a 0.22μm Sterivex-GV-filter using a Masterflex peristaltic pump for further microbial DNA extraction and analysis. The Sterivex filters were with drained of seawater and filled with 1.8 mL of lysis buffer.

In addition to these experiments, I collected depth profile samples for $DMSO_p$ and $DMSO_d$ as well as DMS, and $DMSP_d$ and $DMSP_p$ at 10m, 20m and 40m. At P26, at 10m and 40m, I collected samples for an extended depth profile down to 120m and size fractionated (>5μm, >1μm, >0.2μm) DMSOp measurements for 10 and 40m depths. For my co-worker Dave Semeniuk's incubation, I also collected and analyzed $DMSO_p$ and $DMSP_p$ on day 0, day 2 and day 4 of the incubation for 3 replicates in 5 treatments. Dissolved depth profile measurements were filtered through 0.2 μm Acrodisc filters according to Kiene and Slezak [2006]. Particulate measurements were calculated by subtracting dissolved from total DMS/P/O measurements. Triplicate samples were analyzed using a purge and trap sparging system (publication on this method in progress), a helium carrier and a Hiden Analytical triple filter quadrupole mass spectrometer equipped with a 750 mA emission current.

Gas ion currents are measured with a mass to charge (m/z) ratio of 62, 65, 68 (stable isotope DMS compounds) detected using an electron multiplier with a voltage gain of (900) V every ~20 seconds.

Briefly, 60ml subsamples were sparged using helium at a rate of 500ml min^{-1}, passed through a column and loaded into a trap at room temperature. After completing sparging, the trap was heated to ~200°C and a sample was injected into the mass spectrometer every ~10 minutes. Subsamples were measured every ~30min from incubations from 2-5L of samples collected from P4, P8, P12, P16, P20, and P26. Samples were incubated in UVT PFA Welch fluorocarbon bags to ensure zero headspace in open air incubators at in situ temperature in neutral density screening.

Rate measurements were coupled with underway measurements of several other dissolved gases and hydrographic parameters using two separate underway systems. Dissolved gasses, namely DMS, $C0_2$, 0_2, Ar, and N_2 were measured underway using the MIMS sampling system, developed at U.B.C. (Gueguen & Tortell 2008). Surface seawater from (~5m depth) was pumped through a sampling cuvette at a rate of 500 ml min^{-1} with a digital gear pump and maintained at in situ temperatures using ~20ft of stainless steel tubing immersed in a 14 ^{o}C water bath. The seawater passes through a sampling cuvette, equipped with a 0.01 inch thick dimethylsilicone membrane, where gasses permeate into the vacuum chamber of a Hiden Analytical quadrupole mass spectrometer, (settings as above). Measurements are made every ~30 seconds, providing a spatial resolution <= 200m along the cruise track. O_2/Ar and CO_2 measurements were calibrated with air saturated and ~ 100ppm, ~360ppm and ~600ppm CO_2 saturated seawater samples respectively. DMS standards were prepared using dilutions of liquid DMS in deep seawater every 2-3 days to determine DMS concentrations in surface seawater samples.

Additional ancillary measurements of biological parameters, including Chlorophyll *a*, HPLC, bacterial flow and productivity, Fv/Fm, an indicator of phytoplankton stress, PON/C/S, and nutrients were collected and processed by my co-workers from UBC or myself.

Carbonate Studies, JP Tully 2011-27, August 16th to Sept 1st – Mike Arychuk and Kyle Simpson, DFO/IOS.

Objective: measurement and monitoring of four components of the carbonate system along Line-P, Ocean Station Papa program. Both pH and underway continuous automated pCO2 are measured onboard the *CCGS Tully*, while samples for DIC and TA are collected, preserved and returned to the shore-based lab for analysis.

1) pCO2

Due to an undiagnosed problem in the previous Line-P expedition (June 2011) the spare IOS LiCOR was used. A problem with the initial set up caused a short delay in initial calibration. Data collection began at roughly station P4 (actual location was 48 37.643N x 126 22.211W on August 18th at 15:34(pst). Data collection continued until the ship returned to the Juan de Fuca Strait on August 31st and was stopped at 07:45(pst) (48 39.555N x 123 28.497W)

The forward air intake was used for the entire trip. Surprisingly there was almost no evidence of stack gas being analyzed, although this could be an artefact of when the instrument was visually observed. A closer look at the data is needed to confirm this.

2) DIC/TA Dissolved Inorganic Carbon and Total Alkalinity sampling

DIC/alkalinity samples were collected in pre-combusted 500ml bottles and preserved with 100µl of saturated $HgCl_2$ solution at stations P2, 4, 12, 16, 20, 26 and a calibration cast at P24 (depth 2000m), please refer to the rosette logs for exact sampling depths. The ground glass stoppers were greased with Apiezon-m grease and tapped closed with electrical tape. One duplicate was collected at each station between 1000 and 3000m as well as a duplicate bottle tripped at one of the deeper depths.

A calibration cast was conducted at P24 on the way to OSP (5 Niskins tripped at 2000m were sampled in triplicate). Station P26 was sampled in duplicate for DIC/TA except for a few depths which were only sampled once as we ran short on bottles. Sampling was carried out by a variety of personnel.

Station:	Caps grease by:	Sampled by:	Preserved by:	Taped by:
P2	Kyle Simpson	Marie Robert	Nari Sim	Kyle Simpson
P4	Kyle Simpson	Mike Arychuk	Mike Arychuk	Mike Arychuk
P12	Kyle Simpson	Marie Robert	Moira Galbraith	Kyle Simpson
P16	Kyle Simpson	Marie Robert	Moira Galbraith	Mike and Kyle
P20	Kyle Simpson	Marie Robert	Moira Galbraith	Kyle and Moira
P24 – calibration	Kyle Simpson	Marie Robert	Jason McAlister	Kyle and Jason
P26	Kyle Simpson	Marie Robert	Moira Galbraith	Kyle and Mike

3) pH

Samples for pH analysis were collected and analyzed at stations P2, 4, 12, 16, 20, 26 and a calibration cast at P24. All samples were analysed using the Agilent (HP) spectrophotometer and the m-cresol purple technique of Clayton and Byrne. Cells (100mm cylindrical glass) were filled directly from Niskins. They were stabilized at 25° C using a constant temperature bath and the IOS aluminium block. A temperature controlled cell holder was also used to maintain sample temperature at 25° C. The profiles collected were consistent with DIC/TA depths at all stations as well as the calibration cast at P24. In addition at station P24, a 6th Niskin was closed at 2000m in order to test the effects and operational requirements (water use, rinsing, sampling speed etc) of using an opticap (0.2µm) filter when sampling for pH. The depth of 2000m was chosen as it was expected that at this depth any difference observed in pH are expected to be an artefact of the filtration processes as biological activity is expected to be low, and all other variables are kept the same. In an attempt to get statistically significant data, 6 samples were collected from the filter following a triplicate sampling (unfiltered). All samples collected at the calibration station were labelled in the order they were collected (A, B, C, etc) in order to also test the hypothesis that pH may be altered by the sampling process itself, i.e. atmospheric interaction inside the Niskin during the sampling process.

The pH analysis system was set up in temperature controlled lab (instrument lab). The lab temperature remained relatively stable throughout the trip. The in-room temperature control unit was set to heat at 23C and cool at 24.5. The heat generated by the Spec, water bath and computer were more than enough to keep the unit in cooling mode at all times when analysis were taking place, which kept the temperature in the room very constant. The temperature of the seawater measured inside the cells post analysis was very consistent 25.00+/- 0.05C n=150, with a few outliers removed. No spec cells were broken during this cruise. To confirm the water temperature prior to analysis a previously broken cell was modified with tygon and silicon tubing, filled with water and semi-permanently fitted with a temperature probe. this made monitoring the temperature of the aluminium block and thus the samples it contained much easier and more accurate. Sample collection and analysis was completed by Kyle Simpson.

4) DOC

Whole water samples were collected directly from the Niskin for Dissolved Organic Carbon (DOC) analysis by Marie Robert and Moira Galbraith for Dennis Hansell (Rosenstiel School of Marine and Atmospheric Science, University of Miami) following the protocol supplied by the Hansell group. The bottles were filled to roughly 80% capacity, frozen upright and stored in a -20C freezer. Samples will be analyzed in the Hansell Lab. Stations and depths sampled were the standard depths at P2, 4, 12, 16, 20, 26. All samples from station P26 were taken in duplicate.

Trace Metal Sampling and Analysis – J. McAlister, A. Posacka, C. Schallenberg, N. Sim, K. Simpson.

Objective: Trace level sampling and analysis of biogeochemicaly important metals along Line-P
Analytes: Al, Cu, Fe(II), Fe(III), Ga, Mn, Zn,
Participants: Jason McAlister (UBC); Ania Posacka (UBC); Christina Schallenberg(UVic), Nari Sim(UBC), Kyle Simpson (IOS)

Deployment of the Trace Metal Rosette (TMR) was challenging, but made possible by the helpful effort of the bosun, Mike, and deckhands Jesse B, Jesse F, Zach, Lawrence, Dave, and Connor. Mike and Jesse B had previous experience with the TMR on Debby Ianson's cruise in 2010 (Cruise # 2010-36) which proved very helpful in training new people. The use of a cement bucket as counter weight on the rosette was continued and assisted with TMR recovery. Conversation with Mike emphasized the importance of using the heave compensator and indicated that use of the boat hooks and a larger landing pad on this cruise was also helpful with recovery. The deckhands were all very cooperative wearing gloves and were cautious of the Kevlar line touching the deck. Chief Engineer Roger and Vaughn were able to quickly solve an electrical issue with the winch. Protective wrapping around electrical connections wore through; additional wraps were added and the problem solved.

Having the Trace metal container on board made sampling much easier as there was enough room for more than one person at a time to sample and all bottles could be brought into the clean space at the same time. A total of 105 depths were sampled at 5 stations, providing exceptionally high resolution trace metal sampling (Table 1). Maintaining trace metal sampling along Line P is essential to understanding biogeochemical cycles, phytoplankton dynamics, and resulting effects to fisheries and the climate. Most of the samples collected on this cruise will be analyzed back in the lab, planned analysis are as follows:

- Nari Sim (UBC) will analyze Mn, providing a tracer of sedimentary inputs along Line P and investigating the redox sensitive Mn through the oxygen minimum zone.
- Amy Cain and Jason McAlister (UBC) will analyze Al and Ga, allowing interpretation of Ga/Al ratios.
- Ania Posacka (UBC) will determine copper speciation along the line P transect including the total dissolved Cu, free and the organically complexed Cu . This will be achieved through a combination of the FIA and electrochemical methods, which in addition will provide information on the variability in the concentration of copper ligands as well as their conditional stability constants (logK) or nature along the line P transect. Samples were also collected for Ye Zhao of Derek Vance's lab at the University of Bristol for analysis of Zn isotopes.
- Kyle Simpson (IOS) and the Cullen Lab at UVic will collaborate to analyze the collected samples for total dissolved (filtered 0.2um) and total dissolvable (non-filtered) Fe.
- Christina Schallenberg (UVic) measured Fe(II) during the cruise at three stations: P16, P20 and P26. The Fe(II) analysis was carried out at sea on acidified samples employing the luminol method. All samples were filtered with an AcroPak 500 filter (0.2 um) prior to measurement. Fe(II) profiles were measured down to a depth of 2000 m. At Station P26, Christina was also able to compare measurements of Fe(II) from GoFlo bottles with measurements obtained from the trace metal pump – a very valuable comparison considering the fast oxidation rate of Fe(II) in surface waters.

The Zodiac was deployed at station P26 (Papa) to collect surface samples for Fe(III) analysis roughly 1Km from the ship to avoid contamination. At the same time a short transect starting roughly 5m from the port side (mid ship) to collect samples mainly to test the hypothesis that the ships activities and apparent use of copper based cleansers might contaminate nearby waters with high amounts of copper and other metals which is valuable information when considering surface and near surface sampling with the TM pumping system

The TM pump was mainly used to collect large volumes of water at major stations for incubation experiments for current and future student at UBC. The TM pumping system performed well most of the time; however, there were two temporary setbacks. First, the pump was unable to self-prime and thus no water was pumped here at station P20. The other incident occurred when the Kevlar line was lowered beyond the limitation (40m) of the pump tubing resulting in the line being pinched (no other damage or loss). A small section of tubing was removed and pumping continued without further issues.

Lastly, many thanks to the captain and crew of the CCGS Tully and to the Chief scientist, Marie Robert: without their hard work and cooperation this work would not have been possible.

Please see following page for Table 1.

Table 1: Sampling depths for total trace metal concentrations

Station	P4	P12	P16	P20	P26
Sampling Depth (m)	5	10	10	10	10
	10	25	25	25	25
	25	40	40	40	40
	35	50	50	50	50
	40	75	75	75	75
	50	100	100	100	100
	75	150	130	130	130
	100	200	150	150	150
	150	250	200	200	185
	175	300	275	240	200
	200	400	300	300	300
	250	600	400	400	400
	300	675	600	600	600
	360	700	800	800	800
	400	800	1100	1000	1000
	600	1000	1200	1100	1100
	700	1200	1400	1200	1200
	800	1400	1600	1400	1400
	900	1600	1800	1600	1600
	1000	1800	2000	1800	1800
	1100	2000		2000	2000
	1200				

Note: Please contact Nari Sim or Jason McAlister for detailed sampling information.