Regional Operations Centre
Canadian Coast Guard – Pacific

PACIFIC REGION CCG VESSEL - POST CRUISE REPORT

NAME OF SHIP/PLATFORM: John P Tully

DATE: **FROM:** 6 June 2009 **TO:** 23 June 2009

SCIENCE CRUISE NUMBER: 2009-09 **SHIP'S PATROL NUMBER:** 09-03

CHIEF SCIENTIST[S]: Marie Robert

SCIENTIFIC PERSONNEL:

Female	Male
Elke Allers (Arizona)	Michael Arychuk (IOS)
Marjolaine Blais (U Laval)	Seth Bushinsky (UW)
Martine Lizotte (U Laval)	Michael Craig (NOAA)
Josiane Mélançon (U Laval)	Damian Grundle (UVic)
Kendra Mitchell (UBC)	Keith Johnson (IOS)
Wendy Richardson (IOS)	Robert Kamphaus (NOAA)
Marie Robert (IOS)	Hugh Maclean (IOS)
Nes Sutherland (IOS)	Ken Morgan (EC – IOS)
	Oliver Wurl (IOS)
	Jian Yang (China)
	Doug Yelland (IOS)

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

INTRODUCTION/PROGRAM BACKGROUND: Line P is a long standing program which surveys a 1400 km long section 3 times annually. Data 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. In addition, it is the best occasion for other projects (e.g. CWS) to access offshore waters.

This cruise (2009-09) was very successful. The weather was good at all times, which really helped. The mooring work was done without a glitch, the Seaglider was found quickly despite the fog, and all stations were completed.

CRUISE OBJECTIVE/OBJECTIVES: Repeat hydrography section. Deploy surface mooring. Service subsurface mooring. Recover Seaglider.

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DAYS ALLOCATED: 17 **DAYS OF OPERATION:** 15

DAYS LOST DUE TO WEATHER: None.

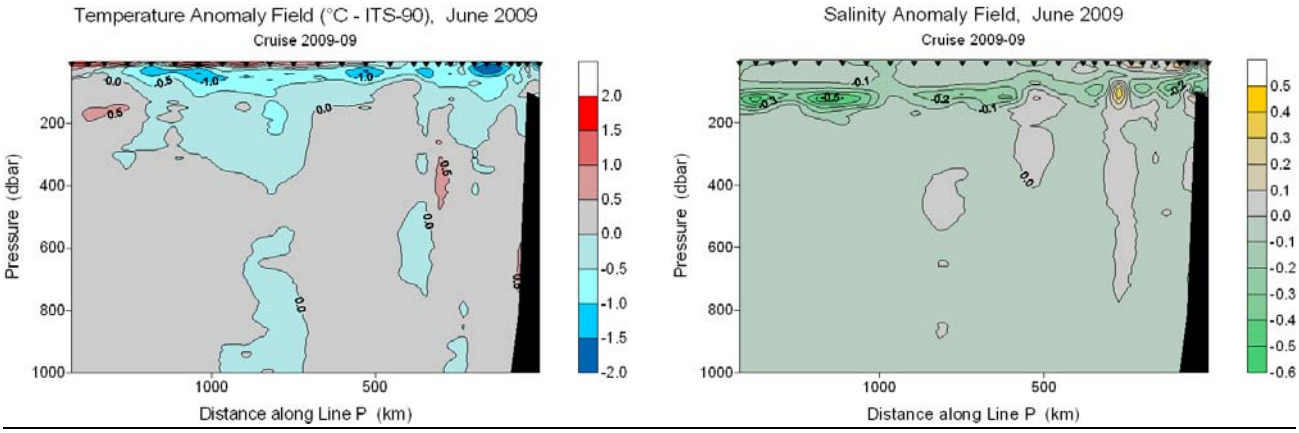
SAMPLING:

- The Line P survey was 100% successful. All stations were completed.
- All the mooring work was also completed without any problem. We deployed the NOAA surface mooring, recovered the sub-surface ADCP mooring and re-deployed it. We also recovered a SeaGlider and deployed another one.
- Many boat (733) rides were done for Surface sampling.
- We used the new chains for pumping and trace metal sampling.
- The samples collected include:
- Underway: **IOS:** T, S, fluorescence, pCO_2, acoustic sounder. –**UBC (Mitchell/Allers):** N_2, O_2, CO_2, Argon, DMS.
- Discrete (casts): T, S, fluorescence, oxygen, transmissivity, irradiance.
- Water: **IOS:** dissolved oxygen, salinity, nutrients, chlorophyll, HPLC, DIC, Alk, DMS, DMSP-p, DMSP-t, pH, Trace Metal (Iron) - **IOS (Wurl):** Rosette: transparent exopolymer particles, total dissolved monosccharides, total dissolved polysccharide to investigate carbon transfer from dissolved to a precursor phase for particle formation in water column. Boat operation: microlayer and 1 m depth sample collection for above parameters to do same calculation. Additional samples collected and analyzed on surfactants to investigate the distribution of microlayers at typical oceanic conditions. Chl-a, secchi depth and PAR measurement for calculation on primary production rate. Additional samples collected for iron analysis to test hypothesis that iron is enriched in oceanic microlayer due to dust deposition (with Keith). - **U. Laval (Blais, Lizotte, Mélançon, Yang):** Fluorescence and Fv/Fm ratio (PAM), Chlorophyll-a, Nutrients, DMS, DMSPt, DMSPd, TDFe, Bacteria, Phytoplankton, N2 fixation, Primary Production - **UVic (Giesbrecht):** ONAr (Oxygen, Nitrogen, ARgon), Oxygen, nutrients, Chlorophyll, DIC, NH4, 13C and 15N productivity experiments. – **UVic (Grundle):** onboard incubation experiments to estimate daily rates of nitrification. Water samples were also collected to measure dissolved NH_4^+, NO_3^-, NO_2^-, PO_4^{3-} and $Si(OH)_4$ concentrations, total bacterial biomass (through the use of DAPI staining) and nitrifying bacterial biomass using FISH (fluorescent *in situ* hybridization). N_2O concentrations were also measured at 150, 300 and 600 metres in addition to the previously stated depths. At each of these additional depths the previously mentioned dissolved nutrient concentrations were also measured. – **UW (Bushinsky):** Oxygen, ONAr (Oxygen, Nitrogen, Argon), Salinity, Alkalinity/DIC, C13, O17, DOC, and C13/N15 productivity experiments – **UBC (Mitchell/Allers):** Bacterial genomic (DNA, RNA), CO_2, CH_4, N_2O, viral particles, bacterial cells.
- Zooplankton using vertical net hauls.

PROJECTS AND RESULTS:

WATER MASSES: Marie Robert, IOS

2008 was a year especially cold and somewhat fresh compared to long-term averages as well as compared to more recent data (2001 to present). The year 2009 started in a much more moderate way, but the deeper waters are still following the 2008 trends: colder and mainly fresher. The surface waters on the other hand are somewhat warmer than the long-term average (1956-1991). Please keep in mind that the data shown here are not processed or calibrated.



Temperature and Salinity anomalies along Line P with respect to the 1956 – 1991 averages.

W. K. Johnson, & Nes Sutherland
Iron/Trace metal Sampling JP Tully 2009-09, June 6th to June 21st

Line P trace metal sampling was carried out with IOS's normal clean sampling methods using the Asti all Teflon pump for 5 to 40m samples and 12L X-Niskins for 75m to 800m. Due to changes during refit the iron sampling location and setup have changed. The HEPA hood is now set up on deck by the new "Chains" just outside the Wet lab. This allowed for much shorter ducting from the Air King blower to the clean hood. The clean hood is used for all pumped samples, 5-40m samples for both unfiltered and filtered (0.2u Opti cartridge) and bulk seawater sampling. There was also a new winch with 6000m of steel line on it with very little room for Kevlar. We were worried that we could not put much Kevlar line on the drum but were able to put ~850m on. The drum is much wider that that of the old Hydro winch and the diameter is larger resulting in more line that we expected loaded on. We are therefore still able to go to 800 meteres. This Kevlar is eleven years old so a new piece should be considered. The winch also needs to have the iron rollers changed as they are already rusting (they were coated with a rubber coating for our work but the steel will wear through it very quickly.
The Zodiac or (733 FRC) was used for subsurface sampling at all the iron stations. We couldn't use the smaller Zodiac as the new crane is not certified to lift people (or lower them into the water) Samples were filtered in the temporary clean "bubble" using pre-cleaned Durapore 0.2u membrane filters. Sampling from the 733 was much improved by the use of a harness that was attached to the opposite side of the craft and allowed the sampler to lean over the edge further without falling in.
Sampling was focused on the major Line-P stations to 150m with only P26 down to 800m. Labile and dissolved iron analysis were completed onboard in the clean tent/bubble. Unfortunately we were not able to analyze many profiles due to the number of samples required from the Laval on deck incubation/iron dust experiment. Three incubation experiments (total 135 samples plus another ~18 for dust dissolution) were performed. One at P04, one at P16 and one at P26. Bulk Trace metal clean seawater was also collected for IOS, U Vic and UBC (8*25L) at either P20 or P26 (5 or 10m). The samples that could not be run were acidified for later analysis for total dissolved and total iron.

Due to the new Geotraces protocol for iron analysis we decided to collect extra samples at P04 and P26 to compare our normal procedures with their techniques. We normally collect 4 samples per depth 2 for analysis onboard (filtered and unfiltered) and two that are acidified with 1 ml of 1:1 conc. Baseline HCl per 125ml seawater for "total" analysis at a later date. Rather than collecting acidified samples for future analysis we collected 2 bottles per depth for 12 hour plus digestion at pH 1.8 as per GEOTRACES protocol. Station P was collected in duplicate.
. Salinities and nutrient samples were collected from all sample depths greater than 50m to confirm depth of sample, although the mixed layer was below 100m.

Sampling Summary for Fe, profiles

Depth	P04	P12	P16	P20	P26
0m	X	X	X	X	XX
5m	X	X	X	X	XX
10m	X	X	X	X	XX
25m	X	X	X	X	XX
40m	X	X	X	X	XX
75m		X	X	X	XX
100m		X	X	X	XX
150m		X	X	X	XX
200m					XX
300m					XX
400m					XX
600m					XX
800M					X X

Notes:

1) The ASTI pump failed to provide enough suction on P 26 (had troubles on P20) so we had to switch to the new backup ASTI pump.
2) The compressed airline in the wet lab had been modified. Our filter regulator did not fir and there is no longer a shut off valve. The engineers were able to replace our fitting so that we could connect to the compressed air. Since we have a three way value at our hood we could shut off the air using it when not using the pump.
3) We had a difficult intermittent contamination problem that was finally tracked down to one of the 10 solenoid valves. New Teflon wetted parts should be purchased for the valves as our spares age getting low. This cost us a few days of analysis.
4) The iron system was run on a 24 hour basis for most of the cruise and still we did complete all the analysis.

W. K. Johnson and Mike Arychuk: Carbonate Studies JP Tully 2009-09, June 6th to June 22nd

We are monitoring four aspects of the carbonate system on expeditions to OSP. Both pH and underway continuous automated pCO2 are measured onboard the Tully. Samples for DIC and TA are collected preserved and returned to the shore-based lab for analysis.

1) pCO2

pCO2 was run using the seawater loop system for the entire expedition up until Juan de Fuca straits (~0800 on June 2st). This was the second trip for the new improved software edition. Again it seemed to work very well.

We ran the entire trip using the forward air intake. This resulted in some stack gases being analyzed at times but this data will be easy to remove from the file. There was more varialbility in the seawater pCO2 than in February but from approximately P16 out to P26 there seemed to be no drawdown of pCO2 in the seawater. In fact the seawater pCO2 was sometimes slightly higher than the air CO2. This should probably be investigated. The AVOS weather data collection worked better this trip and didn't crash which had been a problem on previous trips.

2) DIC/alkalinity sampling

DIC/alkalinity samples were collected in 500ml bottles at all major stations on line P. A new station P02 was added this trip and is to be considered a major station in the future. This made the first sampling day very busy with 2 major stations on one day (P02 &P04).

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 P22 on the way back from OSP (5 bottles for DIC/TA were tripped at 2000m and each sampled in triplicate). Station P26 was sampled in duplicate so that C13 could be measured as well or duplicate DIC/TA if required. We may want to decide if this is necessary to continue in the future. All sampling was done by a variety of personnel.

Stn	sampler	preserved by	sealed by
P02	Marie Robert	Damian Grundle	Keith J
P04	Jian Yang	Doug Yelland	Keith
P12	"	Marie R	Mike A
P16	Oliver	Marie	Mike A
P20	Oliver	Doug	Mike A
P26	Marie,Jian	Hugh, Marie	Mike A
P22	Damian G	Doug Y	Doug Y

Fifteen samples were also collected for U Vic. at specific light depths at three stations (5 per stn).

3) pH

pH was conducted at major line P stations 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^{o} C using a constant temperature bath and the IOS aluminium block. A temperature controlled cell holder was also used to maintain sample temperature at 25C. Profiles consistent with DIC/TA depths were collected from all major line P stations (including P02 for first time) as well as a calibration cast at P22 where 5 Niskins for pH were each sampled in triplicate.

The pH system was moved back and set up in upper lab rather than theTemperature Control lab that was used last trip and was plagued with temperature problems . The upper lab worked out very well again as it was a very calm cruise. Temperature stability was good and the new temperature probe worked very well. It's response was good. It was also very good for measuring the temperature of the sw in the cells after analysis as the se3nsor seemed to be in the tip. There seemed little effect from the portion still in the air. However cell seawater temperatures were not consistent with the block temperature even after more than 2 hours in the block. Most were close but not all. It appears that using one temperature for all samples gives more consistent results than using individually measured seawater temperatures. All samples were collected by Keith Johnson even if it meant waking him up after only 1 hour of sleep. Due to the heavy workload (Fe, HPLC, small boat sampling & pH) samples could not always be run immediately after collection.

Marine Bird Survey, JP Tully - 2009-09

K. Morgan, Canadian Wildlife Service, Environment Canada

Marine birds were surveyed along Line P between 7 and 17 June, 2009. Incidental observations of marine mammals were also made. Table 1 summarizes by species the number of birds encountered (uncorrected for survey effort). A total of 23 species and 2,870 individual birds were observed. While the number of individuals and species diversity was somewhat lower than anticipated, the number of rare species encountered greatly exceeded expectations. Highlights included a single Herald Petrel and three Juan Fernandez Petrels (identification tentative). Neither of these two species has been seen during Line P surveys. If the Juan Fernandez Petrel identification stands, this will be the first time the species has been observed during more than 25 years of CWS pelagic surveys. Other surprise observations included multiple sightings of Hawaiian Petrels and Xantus's Murrelets.

Table 1. Numbers of birds encountered along Line P, 7-17 June 2009.

	P1 - P4	P5 - P8	P12 - P14	P15 - P16	P18 - P20	P20 - P24	P24 - P26
Unid. Alcid	5	1	0	0	0	0	0
Black-footed Albatross	9	2	0	4	4	1	0
Cassin's Auklet	0	3	2	0	0	0	0
California Gull	1	0	0	0	0	0	0
Common Murre	0	1	0	0	0	0	0
Unid. Shearwater	0	0	0	0	75	343	60
Fork-tailed Storm-Petrel	33	94	18	57	37	92	2
Glaucous-winged Gull	25	0	0	0	0	0	0
Hawaiian Petrel	0	0	0	0	2	4	0
Herald Petrel	0	0	0	0	0	1	0
Horned Puffin	0	0	0	0	5	15	1
Juan Fernandez Petrel	0	0	0	0	3	0	0
Leach's Storm-Petrel	0	434	56	80	187	323	8
Long-tailed Jaeger	0	2	0	0	1	1	0
Mottled Petrel	0	0	0	0	3	24	10
Murphy's Petrel	0	0	0	0	3	23	1
Northern Fulmar	4	11	0	2	0	0	0
Pacific Loon	4	0	0	0	0	0	0
Pink-footed Shearwater	8	0	0	0	0	0	0
Rhinoceros Auklet	5	0	0	0	0	0	0
Skua	0	0	0	0	2	1	0
Sooty Shearwater	46	1	0	18	132	243	38
Short-tailed Shearwater	0	0	0	0	5	96	0
Tufted Puffin	0	0	0	4	9	21	2
Xantus's Murrelet	0	4	0	2	0	0	0
Total	140	553	76	167	468	1188	122
Number of Species	9	9	3	7	14	14	8

A total of 7 species and 151 individual marine mammals were seen while conducting the surveys (table 2). A highlight was the large group of Sperm Whales (at least 12 individuals) including two smaller ones; this likely was a group of females and immature males.

Table 2. Marine mammal observations made between 7 and 17 June 2009.

	P1 - P4	P5 - P8	P12 - P14	P15 - P16	P18 - P20	P20 - P24	P24 - P26
Dall's Porpoise	0	0	0	44	50	4	0
Fin Whale	0	0	0	0	3	0	0
Humpback Whale	4	0	0	0	0	0	0
Killer Whale	0	0	0	0	0	4	0
Minke Whale	0	1	0	0	0	0	0
Sperm Whale	0	0	0	2	12	0	0
Northern Fur Seal	1	22	0	2	2	0	0

I would like to thank the officers and crew of the JP Tully, and Marie Robert and the other members of the science team for making this a highly successful and totally enjoyable trip.

Kendra Mitchell, UBC and Elke Allers, University of Arizona, Line P – June 2009

Objectives:
Describe the taxonomic and metabolic diversity of the bacterial communities involved in the cycling of major nutrients and gases along Line P, focusing on the communities in the Oxygen Minimum Zone. Establish underway surface and depth distributions of the climate active gases nitrous oxide (N_2O), methane (CH_4), carbon dioxide (CO_2) and dimethylsulfide (DMS), measure underway surface O_2/Ar gas distributions to infer Net Community Production.

Sampling plan:
Measure dissolved nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), argon (Ar) and DMS continuously at the surface using a membrane inlet mass spectrometer (MIMS).

At the 5 major stations, 1) filter large volumes (up to 120 L) of seawater at 4 depths across the oxygen minimum zone (OMZ) to create genomic libraries of the bacterial communities; 2) filter 1 L samples at 16 depths for high resolution bacterial DNA and RNA extraction and sequencing; and 3) measure the bacterial abundance and the concentration of greenhouse gases (CO_2, CH_4 and N_2O) along a 16 depths vertical profile.

At three of the major stations we collected viral particles as well as bacterial cells from the seawater samples of several depths in order to analyze the viral community within the OMZ and also interactions of virus and potential bacterial hosts.

Comments:
This cruise went very well, although our sampling program is now too complex for 2 people and we have requested a 3rd berth for the August cruise. We particularly liked having all our experiments (MIMS and filtrations) in the same area of the main lab near the sinks and we will definitely try to repeat this setup in future cruises. All Line P stations were visited and we mostly sampled according to plan.
The sampling and filtering for all the bacterial genomics work went smoothly. Salinity samples were taken from all Niskins for our of large volume samples to identify any rosette misfirings. On deck measurements of temperature seem appropriate for detecting misfires and we will continue that precaution on future cruises where we collect large volumes for bacterial concentration. This cruise we had no misfires.

We have gone back to the membrane inlet for the underway gas sampling. This set up is slightly more complicated and requires the use of 2 water baths. However the sensitivity of the instrument to the gases, especially DMS, is much better and will likely be continued in the future. We would like to have the same space for the MIMS (on it's own table next to the sink with the loop) on future cruises if at all possible.

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. Special thanks to everyone who helped us collect samples and covered watches for us while we were filtering.

NOAA/PMEL – Station Papa Moorings – R.Kamphaus, M. Craig

Summary of Mooring Operations

Nominal Site	Mooring ID #	Operation
50N 145W	PA003	Deploy
50N 145W	NP002	Recover
50N 145W	NP003	Deploy
50N 145W	PA003	Buoy ride - repair

The National Oceanic and Atmospheric Administration's (NOAA) Pacific Marine Environmental Lab (PMEL) and University of Washington have enjoyed a very beneficial collaboration with DFO Line P program to maintain moorings at Station Papa since 2007. PMEL participated in the 2009-09 cruise aboard CCGC *John P. Tully* to continue the research moorings at Ocean Station Papa as a part of the global network OceanSITES reference time series. All data from these moorings are publicly available through the project website http://www.pmel.noaa.gov/stnP/ and much of this is available in near-realtime. A subset of the near-realtime data is also available through the Global Telecommunication System (GTS) under WMO ID 48400. PMEL's Ocean Climate Stations (OCS) Program, in partnership with University of Washington, deployed PAPA-2009 (PA003) surface mooring and recovered and redeployed the subsurface ADCP moorings NP002 and NP003. PAPA-2008 (PA002), which was deployed from *Tully* in June 2008, had a wire failure in November 2008, and was recovered from a contract vessel in January 2009. This reduced the amount of mooring work required during this cruise.

Staging and assembly of the buoy at IOS went very smoothly thanks to the assistance of the IOS Winch Shop – Phil, Roger, and Mark. Their assistance in loading the equipment was also invaluable. Loading the majority of the lab equipment through the Helideck worked well. The hydrographic chart room was comfortable for our purposes; it provided adequate space for setup and an instrument check-out. The stowage arrangements on deck worked fine even with the rad van occupying space that had been used in the past for mooring equipment.

Due to forecasted low pressure system moving towards Station P, it was decided to proceed directly from P20 to Station Papa to complete the mooring work before forecasted gale force winds moved in on Monday, 15 June. The ship arrived on station pre-dawn on 13 June, and PAPA-2009 was successfully deployed Saturday morning. PAPA-2009 deployment (PA003/PAPA 0003) deployment went very well. Skipping the CTD stations after P20 and heading straight to the mooring deployment site allowed the aft deck to be cleared and set up for the mooring deployment the day before operations. This was beneficial and gave us plenty of time to set up the deck, talk through the deployment sequence, lay out the wire, and mount instruments.

The subsurface ADCP, NP002, was recovered in the afternoon of 13 June; it also went smoothly. The several hour ADCP mooring recovery did test the limits of the hydraulic capstan; the nearly continuous use overheated the hydraulics and would have required us to stop operations had we not been so close to the end of the recovery (~200m). The Kevlar line did come up tangled in the glass ball floats, but there's little than can be done to prevent that in low current areas. The data from the recovered instruments will be processed over the next several months.

PA003 mooring has an excellent real-time data return. Only a couple sensors were not working – the Vaisala WXT520 weather sensor winds were giving errant values, apparently due to a bad compass, and the 36m DVS still has not produced any useable bins. A buoy ride to swap out the Vaisala sensor was accomplished on Sunday, 14 June; a subsequent buoy ride to swap the Vaisala cable was done late morning Monday, 15 June. The repairs improved the performance of the sensor, but there are still some intermittent anomalous values in the compass data.

The subsurface ADCP mooring, NP003, was successfully deployed the morning of 15 June 09, in much better than forecasted conditions. This mooring is a collaboration with NOAA/PMEL, University of Washington – Applied Physics Lab (APL), and the University of Victoria all providing components. The afternoon was spent triangulating the ADCP mooring, completing a buoy ride, doing a buoy fly-by and returning to P26 for additional water sampling. The ship departed Station Papa/P26 in the evening after about 60 hours on station.

CCGC John P. Tully is a very capable platform to conduct over-the-side mooring operations. The ship's A-frame and aft crane are sizeable and more than sufficient to conduct these operations. We will recommend an additional reel stand be sent for future operations to allow quicker transition between reels, especially those requiring the crane to lift. All deck equipment was in good working order. The new deck fittings, and using the crane for all anchor deployments improve the safety of the operations.

We are very grateful to DFO and Chief Scientist Marie Robert for the opportunity, ship time, bunks and deck space to participate in this cruise. Without this ship time support, the moorings at Ocean Station Papa would not be a reality. Thanks to all the other scientists who gave up some of their valuable sampling time so we could complete the mooring work.

We are especially grateful for the excellent support provided by the Captain and Crew of the *CCGC John P. Tully*. Captain Murray McGregor provided excellent communication and ensured we had everything we needed from the ship. The cooks and stewards kept us well fed, thanks! The Chief Officer, Duncan McCallum's experience and keen safety eye were evident on the back deck; he also supported us during two small boat rides – one pretty rough and wet one – to complete repairs to the surface mooring. The bridge officers skillfully handled the ship for all mooring operations.

The deck crew, led by Boatswain Glenn McKechnie, did an excellent job during all mooring operations. Operations were conducted safely, calmly, and there was good control of equipment. The crane was operated skillfully by Leading Seaman Johnny Luzney; he also showed he is a very competent small boat coxswain during the two small boat rides to the buoy for repairs. Leading Seaman Rod Parsons experience was also very beneficial as he saw a couple steps ahead and anticipated what was coming next; he also showed his skill as a small boat coxswain during the ADCP recovery. The watchstanding deckhands, Kurt, Bill, Gordon, and Francois, were all very helpful and eager to help with the operations – and any time it was needed.

Thanks also to the Engineering department for some machine work on a buoy part before deployment, clutching and de-clutching during acoustic triangulations, and keeping the ship in good working condition to complete all operations.

It was a very successful cruise for the NOAA/PMEL and UW moorings team.

Seth Bushinsky (University of Washington)

The transport of carbon from the atmosphere into the ocean plays a major role in controlling the carbon dioxide content of the atmosphere. This flux is driven both by physical absorption and biological production. The amount of biologically produced carbon that is exported to the deep ocean can be measured by making precise oxygen measurements. These oxygen measurements, coupled with measurements of biologically inert gases such as nitrogen and argon, allow distinction between physical processes that affect gas saturation from biological production and consumption of oxygen.

Our measurements focus on oxygen, nitrogen, and argon, as well as constraining the rest of the carbonate system through the measurement of alkalinity, dissolved inorganic carbon, dissolved organic carbon, and pH. Additionally, ^{17}O and ^{13}C were measured and $^{15}N/^{13}C$ incubations were preformed to estimate biological production.

We deployed a Seabird Seacat on the Papa mooring to measure temperature, salinity, oxygen through both a Seabird 43 and Aandaeraa optode, and total gas pressure from a Gas Tension Device. Additionally, we deployed a SAMI pH sensor that will communicate with the NOAA-PMEL pCO_2 system and report pH in real time.

Finally, we recovered a SeaGlider that has been profiling beneath the Papa mooring location for 9 months, measuring temperature, salinity, pressure, oxygen (again using two separate sensors), fluorescence, and backscatter. This glider mission represents the longest autonomous vehicle deployment ever successfully completed. A new glider was deployed to continue sampling.

Thanks to the rest of the science party and to the crew of the Tully for all of their help during sampling, deployment, and recovery. Much of this could not have been completed without the generous help I received.

June 2009 Line P cruise report, Université Laval, Québec City, Qc, Canada

Martine Lizotte, Josiane Mélançon, Marjolaine Blais, Jian Yang

Biogeochemical Impacts of Asian Dust on the North Pacific Ecosystem and Climate

The central objective of this project was to determine the impact of atmospheric dust deposition originating from the Asian deserts on the North Pacific ecosystem and on climate. The biological productivity of ca. 40% of the global ocean is limited by the atmospheric depositions of iron from desert dust. The North Pacific represents one of these oceanic regions limited by the supply of iron and Asian deserts, including the Gobi desert, represent the main source of dust for the North Pacific. Episodic natural fertilisations can influence the capacity of the oceans to absorb or emit a range of climatically active gases such as carbon dioxide (CO_2) and dimethylsulfide (DMS). We proposed to further our investigations by fertilising water samples from the North Pacific with dust samples collected from different Chinese deserts and for which a full chemical characterisation has been conducted. Our experiments will help us to determine the impact of these fertilisations on the plankton ecosystem in general and more particularly on the dynamics of CO_2 and DMS.

During this cruise, water samples were collected at Stations P4, P16 and P26 at 5 m depth by pumping water with a teflon diaphragm pump to avoid trace metal contamination. Samples were collected in acid-clean 5-L labtainer collapsible bags for incubation. Before the start of the incubation, the water samples were subjected to the following treatments (in triplicate):

Identification	**Treatment**
Control	No addition
Treatment 1	Addition of FeSO4 (+ 0.6 nmol L^{-1})
Treatment 2	Addition of dust from Beijing (+ 2.0 mg L^{-1})
Treatment 3	Addition of commercial dust CJ2 (+ 0.12 mg L^{-1})
Treatment 4	Addition of commercial dust CJ2 (+ 0.5 mg L^{-1})
Treatment 5	Addition of commercial dust CJ2 (+ 2.0 mgl L^{-1})

The incubation bags were hermetically sealed and incubated during 48 to 96 h in outdoor incubators at *in situ* temperature and irradiance on the helicopter deck of the CCGS John P. Tully. Measurements of incubator water temperature, ambient photosynthetic active radiation (PAR), ultraviolet (UVA and UVB) radiation, and windspeed were taken every ca. 4 hours during work hours. The following variables were monitored at T0, T24, T48 and T96: chlorophyll *a* (chl *a*) concentrations, nutrients, phytoplankton enumeration and identification, bacteria enumeration, fluorescence, photosynthetic efficiency (Fv/Fm ratio), labile Fe concentration, particulate organic carbon (POC) and particulate organic nitrogen (PON), dimethylsulfoniopropionate (DMSP) concentration, and DMS concentration. Precautious sub-sampling of the incubation bags took place inside a laminar flow hood located in the radvan. Furthermore, 1-L bottle incubations were run in parallel to the bag incubations to determine rates of N_2 fixation ($^{15}N_2$) as well as primary production ($^{13}NO_3$ – $^{13}HCO_3$). Samples of DMS, labile Fe, chl *a* and nutrients were analyzed onboard the ship within hours of collection. The remaining samples will be brought back to Laval University in Quebec City for analysis.

Overall, experiments conducted during this cruise ran smoothly. We did however encounter some problems with trace metal contamination in some of our incubations but it is difficult to pinpoint where this contamination may have come from. We were able to finish the experiment on a positive note with our last sampling time points

being free of Fe contamination. Before starting experiments at station P26 (PAPA), we also realized that starting the sampling during the night was not optimal since we were exposing plankton cells to higher amounts of light inside the radvan than in the incubators which led to light-induced stress. But thanks to Marie Robert, who was so accommodating, we were able to correct this situation for station PAPA and started sampling during daylight hours. Being able to work in the radvan really contributed to the success of our experiments. There was ample storage room and counter space as well as flowing seawater allowing us to keep our incubation bags at *in situ* temperature during subsampling. Being closer to the incubators was also a very positive aspect of working in the radvan as this limited the number of stairs to climb up and down from the helideck and made our subsampling that much safer. A few concerns about the radvan would include the door that was difficult to open and the heater/air conditioning system that we could not figure out how to close completely.

We would like to thank Marie Robert for her amazing leadership, professionalism, and enthusiasm. Marie you are truly one of the best chief scientists we have encountered and you have made our work so much easier and pleasurable. We are also truly thankful to Michael Arychuk for running DMS analysis with keenness, hard work and an incredible sense of humour. We wish to thank Keith Johnson and Nes Sutherland for their constant and tireless efforts with Fe analysis; it has been a real pleasure working with you and we wish to thank you for the tips on metal clean techniques. Thanks also to Wendy Richardson for nutrient analysis and patience/tolerance with our “nutrient-rich” samples!! A great big thank you to Darren Tuele for pre-cruise preparations; your amazing help and imaginative designs for the incubators and the radvan were really appreciated… you made our work so much easier onboard the ship! We would also like to extend our thanks to Captain McGregor and all the crew of the CCGS John P. Tully for their invaluable help and assistance. A special thank you to the chief engineer Jean-Luc Arsenault and senior engineer Gabriel Chaikin for periodically fixing incubator fittings during the cruise and for making sure that things were always running smoothly. Last but not least thank you to the cooks for keeping us well fed and happy.

CRUISE REPORT FOR LA PEROUSE 2009 AND LINE P JUNE 2009 - Oliver Wurl

I. Existence of sea-surface microlayers under oceanic conditions

The sea-surface microlayer (SML) plays an important role in air-sea interactions, in particular for greenhouse gases affecting the global heat budget. This interfacial region between ocean and atmosphere is often enriched in naturally occurring surfactants affecting air-sea gas exchange processes. It is unknown to what extent the open ocean’s surface is covered with a surfactant film, but it was assumed to exist, at least temporally, during periods of high primary productivity (Asher, 1997). Initial results from field work at Santa Barbara Channel showed that the SML exist at relative high wind conditions (up to 9 m/s) (Wurl et al., 2009) at which its existence is often questioned due to dispersion. However it was suggested that air bubble plumes created by breaking waves acts as a upward transport vector for the dispersed surfactants, which are readily adsorb to the air-water interface of the bubbles.

During the La Perouse and Line P cruise, 36 samples from the SML and bulkwater (1m depth) have been collected at wind speeds ranging from 0.7 to 9.5 m/s. Shipboard analysis on surface-active substances (i.e. surfactants) showed that none of the SML samples were depleted in such substances with enrichment factors, relative to the bulk water, between 1.2 and 4.9. It further indicates the ubiquitious existence of the SML under typical oceanic conditions, that means above a global average wind speed over the ocean of 6.6 m/s.

Further measurement on chlorophyll concentration, secchi depth, water temperature and PAR will be used to compute primary production, the primary source of natural surfactants.

The data will be included in a database on surfactant concentrations in the SML and bulkwater, wind speed and primary production, which currently consist of about 300 datasets. The project, funded by the German Research Foundation (DFG), has the goal to find relationships between the existence of the SML to the primray production and wind conditions.

II. Particle formation through spontaneous assembly of DOM

The formation and sinking of biogenic particles mediate vertical mass fluxes and drive elemental cycling in the ocean. Whereas marine scientists have focused primarily on particle production by phytoplankton growth, particle formation by the assembly of organic macromolecules has almost been neglected. Transparent exopolymer particles (TEP, see Fig. 1) does not originate from cell growth, but spontanous assembly from dissolved polysccharides. Owing to their surface-reactive nature, TEP support coagulation processes and enhance the formation of large particle aggregates (marine snow), which in turn accelerate carbon export to the deep sea.

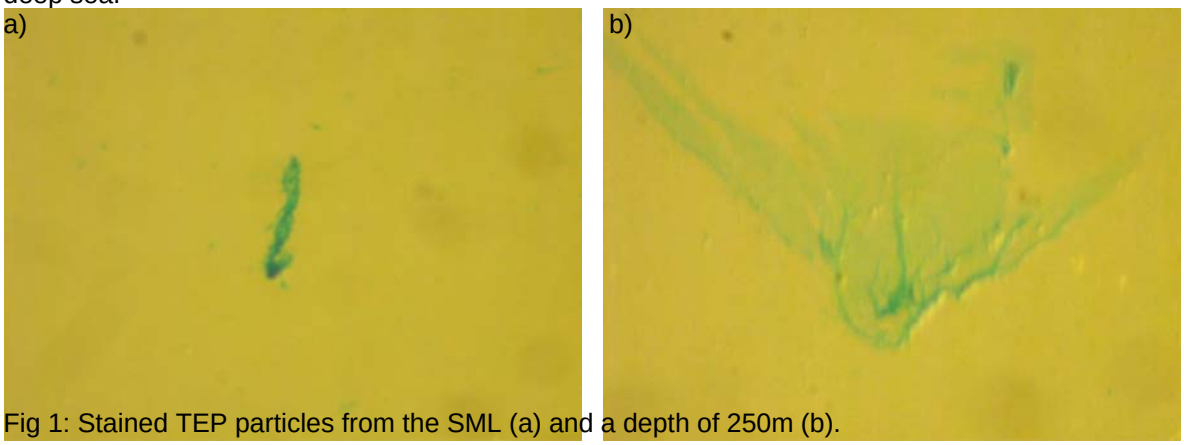


Fig 1: Stained TEP particles from the SML (a) and a depth of 250m (b).

It has been shown that gel-like TEPs are enriched in the sea-surface microlayer (SML) and gives this layer a gelatinous composition (Wurl and Holmes, 2008).

During the La Perouse and Line P cruise, samples from the SML down to the deep ocean (down to 4300m) have been collected for the first time for the analysis on TEP and polysccharides with the aim to compute TEP production using an aggregation model (Engel et al. 2004). TEPs are a precursory stage of the formation of marine snow which acts as carbon export to the deep ocean.

The shipboard analysis of TEP shows that the TEP concentration in surface waters (down to 20m) are 20 to 30 times higher than in deep water (> 1000m). It has been also revealed that TEP are frequency enriched in the SML relative to surface waters (1m depth) with typical enrichment factors of 1.5 to 4. The analysis on polysccharide has not been completed yet, but the TEP enrichment may indicate that the SML is an important location for the formation of TEP.

III. Iron enrichment in the sea-surface microlayer (only Line P)

As iron stimulate phytoplankton growth and a major pathway of the minor nutrients is dry deposition on the ocean's surface, a study on iron concentration in the SML and bulkwater has been initiated with Keith Johnson and Nes Sutherland. Seven samples have been collected and analyzed on the ship. Initial results show that iron is enriched in the SML, but final concentrations are not avialable yet. The results need to be carefully evaluated as the glassplate used to collect the SML has introduced some contaminations to the samples. Experiments for the blank estimation of iron in SML samples has been conducted and needs further evaluation prior finalizing concentration data.

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Damian Grundle (PhD Student, University of Victoria, Canada)

Data collected during this cruise was part of an ongoing study of nitrification (i.e. the biological oxidation of NH_4^+ to NO_3^-) along Line P in the NE Pacific Ocean. During previous Line P cruises we discovered significant rates of nitrification occurring in the euphotic zone of the NE Pacific. Traditionally, nitrification was thought to be limited to depths below the euphotic zone indicating that any NO_3^- present in the euphotic zone was a direct result of upwelling and consequently any NO_3^- based primary productivity was considered to be "new primary production". A number of studies of "new primary production" have been conducted along Line P and these rates have been used to estimate *f*-ratios and potential carbon export rates in the NE Pacific ocean. However, our finding that nitrification occurs within the euphotic zone suggests that previously calculated rates of "new primary production" and potential carbon export have been overestimated. In order to revaluated previously calculated rates of "new primary production" and carbon export from the euphotic zone a much better understanding of the spatial and temporal variability of euphotic zone nitrification along Line P is required. To this end, the primary objective of this cruise (and future Line P cruises) was to measure nitrification rates throughout the euphotic zone at each of the major sampling stations (i.e. P4, P12, P16, P20 and P26) along Line P, and to assess how varying chemical, physical and biological factors affect these rates.

At P4, P12, P16, P20 and P26 samples were collected from depths corresponding to 100, 55, 30, 10 and 1% of surface incident irradiance for the purpose of conducting onboard incubation experiments to estimate daily rates of nitrification at each station. Water samples were also collected to measure dissolved NH_4^+, NO_3^-, NO_2^-, PO_4^{3-} and $Si(OH)_4$ concentrations, total bacterial biomass (through the use of DAPI staining) and nitrifying bacterial biomass using FISH (fluorescent *in situ* hybridization). N_2O concentrations were also measured at 150, 300 and 600 metres in addition to the previously stated depths. During previous cruises nitrification rate measurements were conducted using short-term dark incubations and hourly rates were extrapolated to estimate daily rates. However, given the potential for photoinhibition of nitrification to occur during the day it was unclear as to whether our extrapolated daily rates were overestimated. To this end, the protocol employed during the present cruise consisted of incubations conducted under both dark and *in situ* light conditions so as to determine whether nitrification rates become retarded under day light conditions. In addition, ammonium addition experiments were conducted in order to confirm our previous assumption that nitrification rates along Line P are limited by ammonium concentrations. Finally, CTD instrumentation was used to obtain vertical profiles of temperature, salinity, PAR, *in situ* fluorescence (chlorophyll *a* + phaeopigments), and oxygen concentrations.

Consistent with previous Line P cruises, nitrification was found to occur throughout the euphotic zone during the present cruise. Results pertaining to the comparison of nitrification rates estimated under dark and *in situ* light conditions showed that there were no differences in nitrification rates between these two treatments, thus indicating that short-term dark incubations are a sufficient means to estimating daily nitrification rates. Furthermore, preliminary results obtained from the ammonium addition experiments appear to confirm our previous assumption that nitrification rates in the NE Pacific Ocean are substrate limited.

I am extremely grateful to Marie Robert and the rest of the IOS science party for allowing me to participate in this cruise and for accommodating my sampling requirements. Sampling requirements and sampling schedules were organized in a very efficient manner, and was key to enabling me to ensure that samples were collected at each of my planned sampling stations and that onboard experiments were run immediately following sample collection. Thanks also to Janet Barwell-Clarke and Wendy Richardson for allowing me to use the IOS TD-700 fluorometer to measure dissolved NH_4^+ concentrations. I would also like to thank the Captain and crew of the CCGS John P. Tully for all their help in the collection of samples and for ensuring that the needs of the scientists onboard were met.

RADIOISOTOPE USE:

No radioisotopes were used during this cruise.

PROBLEMS [SCIENTIFIC GEAR AND OPERATIONS]:

We had MAJOR problems with the main CTD data acquisition computer. It kept rebooting during casts, while the CTD was in the water. We had to re-do certain casts and a station because of this problem. Fortunately it never happened while the CTD was near the bottom. But this problem will definitely compromise the data processing for this cruise.

The remote temperature sensor was not hooked to the thermosalinograph, therefore we have no temperature at input.

The PAR sensor got one of its four pins bent and taken off. Unfortunately the spare sensor was not discovered right away, therefore, one of the light casts was done using previous light-depth.

The main CTD data acquisition computers **really** need to be taken off the regular IT rules. Most of the common computers on board have "science" as user name and "science" as a password. These computers need to be accessible by everyone. Having password rules on sea-going computers is nonsense. Having the McAfee Virus Protection software was also a problem since we could not install some of the needed software.

SUCCESSES [SCIENTIFIC]:

We did the last 7 casts of Line P and the 11 casts of the LD line (La Perouse cruise) from the new CTD Lab. Despite the fact that it is not in its final configuration, it seems that "the Closet" will be a better place to do the CTD casts from than the main lab.

All the mooring work was completed, and it all went really smoothly. We located the SeaGlider in only 20 minutes or so despite the heavy fog that evening, and the deployment of the replacement SeaGlider also went without problems.

Because of the fantastic weather, we had enough time to complete the LD line, which had to be dropped from the previous cruise (La Perouse) due to various reasons. This is the first time that the coastal work (Rivers Inlet, Koeye River, SS Line) was performed on the La Perouse cruise, and only the Line P stations were done during the Line P cruise (except, in this case, for LD line). It seems to be the best way to share the work hence forth.

Thanks to Doug Yelland for coming back early from the La Perouse cruise so that we could start loading the Line P gear on the Friday before the official start of the cruise.

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

The "Email at Sea" system is still locking up every time the ship is on a specific heading. Is there a way to re-locate the receiver so that this problem can be avoided?

SUCCESSES [SHIP]:

Although there were no radioisotopes used on this cruise, we used the "rad van" simply as an extra lab. This worked extremely well, especially since the main lab was quite crowded. Being able to work in the data room, aft of the ship's office, is also a very valuable bonus in order to separate certain chemicals which otherwise could contaminate others' samples.

Thanks to the joint efforts of Darren Tuele (IOS) and the Tully engineers, we had no problem with the loop system during this cruise, despite having four large incubators on the heli-deck, as well as loop water flowing in the main lab and the Rad Van.

We used for the first time the "Milli-Q" maker in the lab, bought by science but installed by the ship's crew during the April Out-of-Service period. The clean water maker is definitely a good addition to the ship's equipment, and will reduce the number of litres of clean water we have to bring on board.

DELAYS [OTHER THAN WEATHER]:

About five hours for oil clutch changes.

SAFETY CONCERNS:

None.

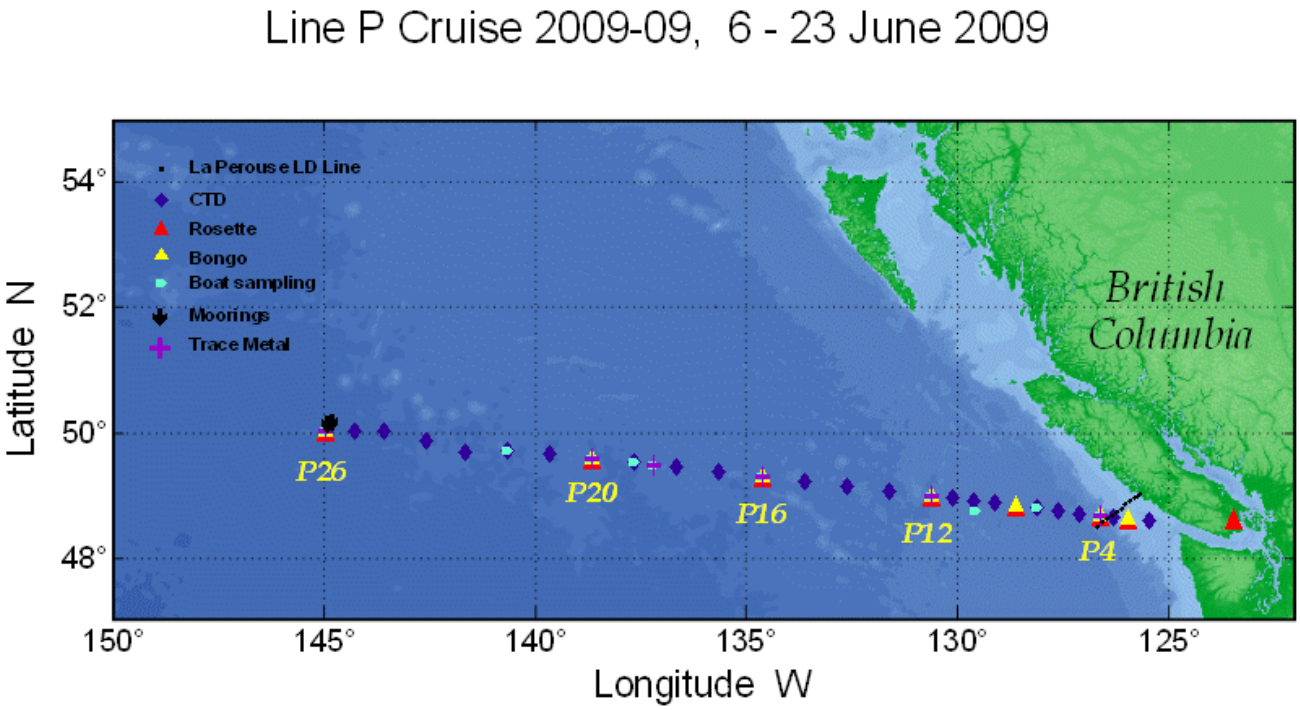
HAZARDOUS OCCURRENCES:

None involving science personnel.

EVENT LOG:

DATE		OPERATIONS
Friday	**5 Jun:**	**Start loading the ship at IOS.**
Saturday	**6 Jun:**	**Finish loading. Test cast in Saanich Inlet. Leave Pat Bay.**
Sunday	**7 Jun:**	**Start Line P.**
Friday	**12 Jun:**	**Complete station P20, go straight to P26.**
Saturday	**13 Jun:**	**Arrive at Station Papa. Deploy Surface mooring. Recover subsurface mooring. Recover Seaglider**
Sunday	**14 Jun:**	**Rosettes at Papa. Deploy Seaglider.**
Monday	**15 Jun:**	**Deploy subsurface mooring. Leave Station Papa. Start CTDs from P35 to P19.**
Saturday	**20 Jun:**	**Do La Perouse line LD.**
Sunday	**21 Jun:**	**Pick up new engineer off Victoria. Arrive at IOS and start offloading.**

CRUISE TRACK:



SUMMARY/FINAL COMMENTS:

- Thanks to **everyone** on board for such a successful cruise. EVERYTHING went well.
- Many thanks to the whole galley crew for keeping us so well fed and taking such good care of us with great smiles! Thanks too for cleaning all the cabins so efficiently on Friday 5 June so that the Line P participants coming from out of town could spend the night on board, as well as for keeping some of us until the last day.
- Thanks also to Paddy Murphy and the ROC for relocating the cadet that was supposed to be on the Tully for this cycle so that we could have the full complement of scientists (19).
- Chantale, we're thinking about you!
- Finally, thanks to the whole White Crew for three great Papa cruises since last August. Wishing you happy and smooth sailings, and we'll see you all again in August 2010!