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:** 5 June 2010 **TO:** 22 June 2010

SCIENCE CRUISE NUMBER: 2010-13 **SHIP'S PATROL NUMBER:** 10-03

CHIEF SCIENTIST[S]: Marie Robert

SCIENTIFIC PERSONNEL:

Female	Male
Jessie Motard-Côté (U Laval)	Michael Arychuk (IOS)
Constance Couture (UBC)	Michael Bentley (CWS)
Josiane Mélançon (U Laval)	Seth Bushinsky (UW)
Marie Robert (IOS)	Michael Craig (NOAA)
Maureen Soon (UBC)	Roger François (UBC)
Jody Wright (UBC)	Keith Johnson (IOS)
	Yiming Luo (UBC)
	Hugh Maclean (IOS)
	Keith Ronnholm (NOAA)
	Karl Schiffmacher (UBC)
	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 (2010-13) was very successful. Despite a few days of rough weather we managed to accomplish all the planned work. The mooring work was very well done, and all stations were completed.

CRUISE OBJECTIVE/OBJECTIVES: Repeat hydrography section. Deploy two surface moorings. Recover two moorings (one surface, one subsurface). Deploy three Argo floats.

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

DAYS LOST DUE TO WEATHER: ~1.5

SAMPLING:

- The Line P survey was 100% successful. All stations were completed.
- All the mooring work was also completed. The only problem encountered was the acoustic release not working while recovery of the surface mooring PA-003 (see NOAA report).
- Two Argo floats were deployed for DFO (at P13 and P24) and one Iridium float was deployed for University of Washington at Station Papa.
- The samples collected include:
- Underway: **IOS:** T, S, fluorescence, pCO_2, acoustic sounder. –**UBC (Wright/Couture/Schiffmacher):** N_2, O_2, CO_2, Argon, DMS.
- Discrete (casts): T, S, fluorescence, oxygen, transmissivity, irradiance, pH.
- Water: **IOS:** dissolved oxygen, salinity, nutrients, chlorophyll, HPLC, DIC, Alk, DMS, DMSP-p, DMSP-t, pH - **U. Laval (Mélançon, Motard-Côté):** Chl *a* concentrations, nutrients, phytoplankton enumeration and identification, bacteria enumeration, photosynthetic efficiency (Fv/Fm ratio), dissolved iron and iron speciation, particulate organic carbon (POC) and particulate organic nitrogen (PON), dimethylsulfoniopropionate (DMSP) concentration, DMS concentration, and rates of primary production ($K^{15}NO_3$ – $H^{13}CO_3$) - **UW (Bushinsky):** Oxygen, ONAr (Oxygen, Nitrogen, Argon), Salinity, Alkalinity/DIC, O17, and DOC. – **UBC (Wright/Couture/Schiffmacher):** Bacterial genomic (DNA, RNA), CO_2, CH_4, N_2O, viral particles, bacterial cells, nitrite (NO_2), thiosulfate (S_2O_3), and ammonia (NH_3) – **UBC (François, Soon, Luo):** 230Th, 231Pa, 234^{Th}, Al, Neodymium, and foraminifera.
- Zooplankton using vertical net hauls and multinet.

PROJECTS AND RESULTS:

WATER MASSES: Marie Robert, IOS

2010 started as a warm year. The February coastal subsurface waters were much warmer than the long-term average (1959-1991). It seems that the subsurface waters are still slightly warmer than the long term average. There are also areas of saltier and therefore denser waters just below the surface, between about 80 and 160m, compared to June last year. The same area had fresher (See Figure 1) and less dense (figure 2) waters in June 2009. The increase in salinity in subsurface waters from June '09 to June '10 might be attributed in part to the severe storms of the winter of 2009-2010, of the type that hit us during the February 2010 Line P cruise.

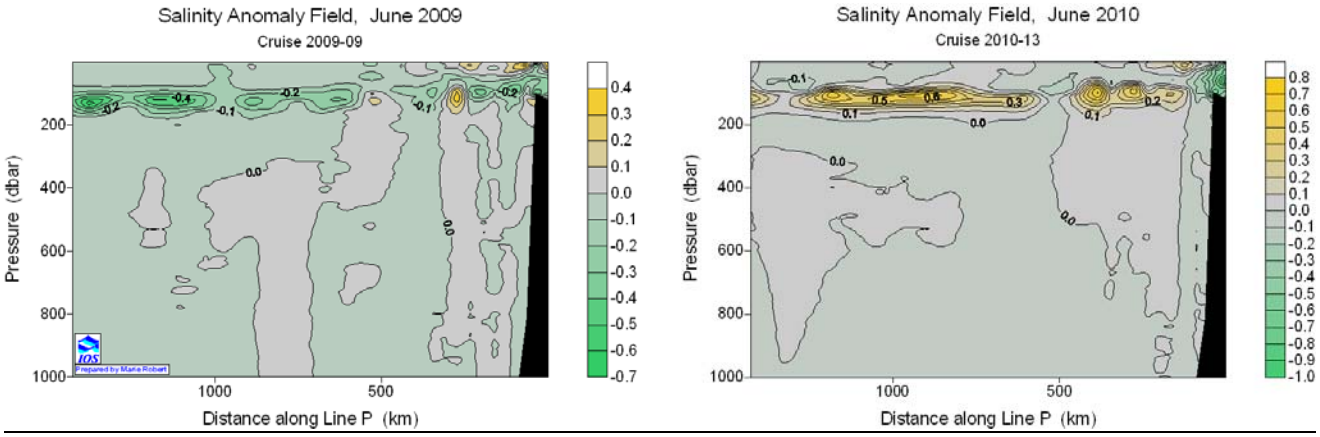


Figure 1: Salinity anomalies along Line P with respect to the 1956 – 1991 averages in June 2009 (left) and June 2010 (right).

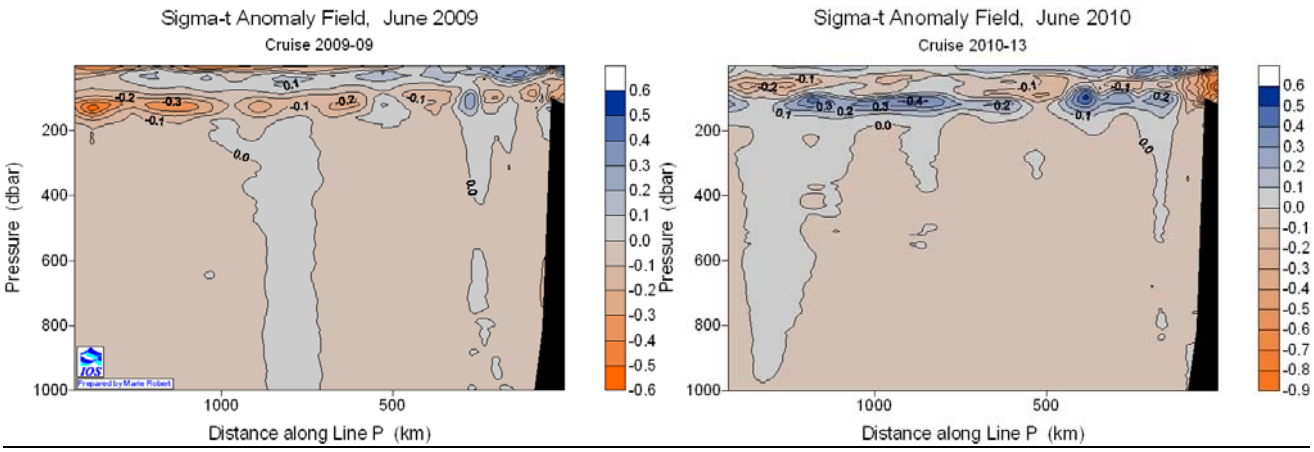


Figure 2: Density anomalies along Line P with respect to the 1956 – 1991 averages in June 2009 (left) and June 2010 (right).

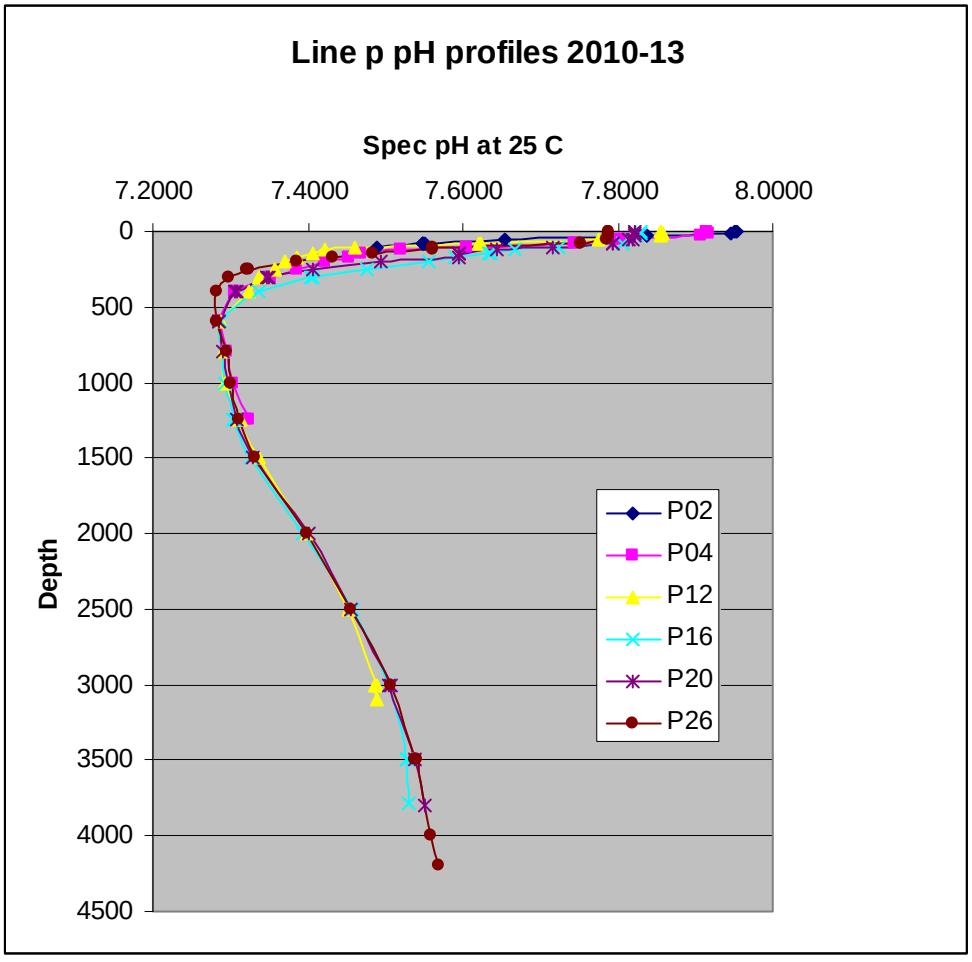
Carbonate System Analysis Cruise 2010-13 **W. Keith Johnson** **June 11th to 21st, 2010**

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) pH

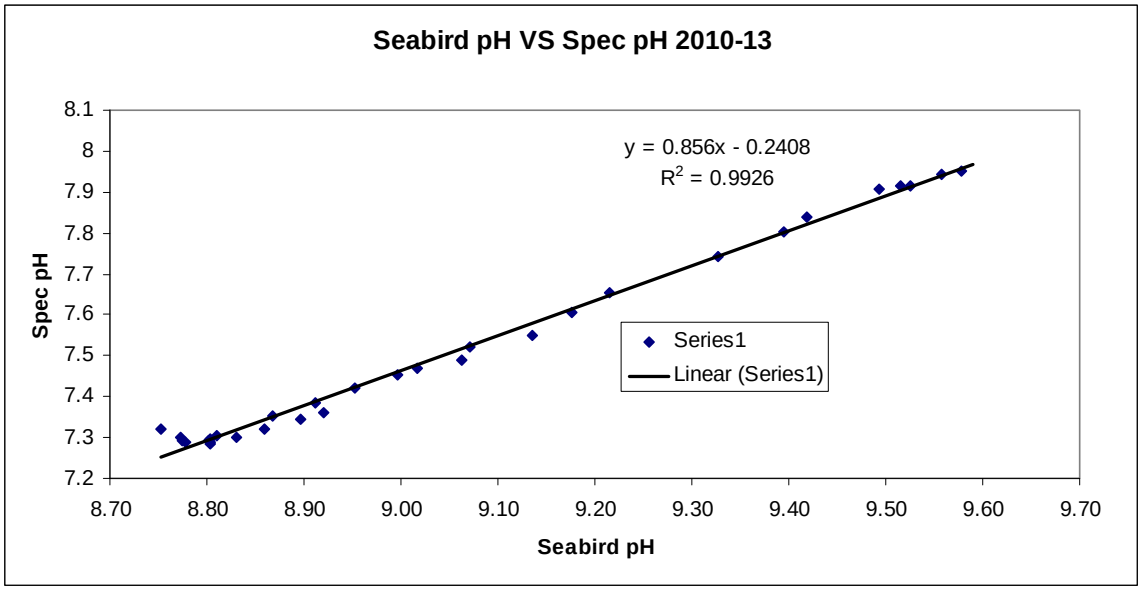
pH was conducted at major line P stations using the new Agilent (HP) spectrophotometer for the first time with no problems associated with it. The method used was the m-cresol purple technique of Clayton and Byrne. Cells (100mm cylindrical glass) were filled directly from Niskins. They were stabilized 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) as well as a calibration cast at P24 where 5 Niskins for pH were each sampled in triplicate.

The pH system was set up the Temperature Control lab as the upper lab has been switched over to the smoking room for the crew. Temperature problems that plagued the system in this lab previously were eliminated to some degree by moving out of the alcove and out into the main section where there was better air flow. Temperature stability was still a problem due to high heat output of the water bath and slow response of the air conditioner. 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. Overall the analysis looked very good for most duplicates. Profiles were very consistent at mid to deeper depths. Surface pH decreased as we travelled eastward.



The calibration cast had mixed results although a lot better than last June Some replicates were very good but a few weren't (first 3 Niskins had a standard deviation of less than or equal to 0.0002 pH units but the other two were 0.0007 and 0.0013 . This could be partially a temperature problem as the temperature of the seawater in the cells increased with time over the entire analysis period. A difference of 0.2 degrees C will cause a change in calculated pH of 0.0028 units. The analysis of a cast can have a change this high or higher over the entire analysis. All samples were calculated using 25.0 ^{o} C.

Extra pH samples were collected from a few profiles down to 1000m along with the Seabird probe to aid in calibrating the probe s is. Calibration was successful at 3 stations P02, P04 & P12. A linear correlation was determined with an R^2 value of better than 0.99



2) pCO2

pCO2 was run using the seawater loop system for the entire expedition up until Juan de Fuca straits (~0800 on June 20th). This was the fifth trip for the new improved software edition. Again it seemed to work very well.

As usual Mike 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. It doesn't seem worth changing the air intake for the small amount of time that we are subject to stack gas intake. The AVOS weather data collection worked well this trip except for one crash which we did not figure out but it started working again the same day so not a lot of lost data.

3) DIC/alkalinity sampling

DIC/alkalinity samples were collected in 500ml bottles at all major stations (including P02) on line P. 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 back from OSP (5 bottles for DIC/TA were tripped at 2000m and each sampled in triplicate). Station P26 was sampled in duplicate calling one DIC and one TA which could beused for other measurments 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. See separate sheet for sampling record of who did what and where duplicates were collected

Biogeochemical impacts of aeolian iron deposition in the eastern North Pacific Ocean: comparison of Asian desert dust and volcanic ashes.

Josiane Mélançon and Jessie Motard-Côté, Université Laval, Québec

Cruise report, Line P, june 2010

Station PAPA is at the core of a region commonly referred to as HNLC: High-nutrient low chlorophyll. It has been well studied that iron is a micronutrient that is limiting the growth in this area. The objective of this multi-year study project is to characterize the biogeochemical effects of natural aeolian iron additions on the planktonic community of the area, more particularly on the dynamics of the climate active gases CO_2 and dimethylsulfide (DMS).

The study started last year with the characterization of the effects of Asian desert dust, thought to be one of the main Aeolian iron sources in the North Pacific. This year, we focussed on comparing the effects of Asian desert dust with another Aeolian iron source that is taking more and more importance in the literature recently: volcanic ashes. Indeed, in 2008, an unusual bloom was observed at Station PAPA during the August cruise. A few days earlier, the Kasatochi, a volcano in the Aleutian Islands, had erupted. It is suggested that the volcanic ashes may have fertilized the ocean around station PAPA and could have caused the bloom.

During the Line P cruise this June 2010, incubations were conducted with additions of CJ-2 dust, a fully characterized commercially available dust collected in the Gobi desert in northern China, and fine volcanic ashes from the Chaiten volcano. The Chaiten volcano, located in Chile, is a subduction zone volcano with a similar composition than the Kasatochi. We unfortunately were unable to obtain the fine fraction ash particles from the Kasatochi eruption, so the Chaiten ashes were used as a proxy. The concentration of dust or ashes added was 2mg/L. Apart from those two treatments, control incubations were also run (no addition for negative control and $FeSO_4$ for positive control). All the treatments were run in triplicates.

Preliminary acidification incubations were also run at P20 in preparation for the August cruise; these will not be described in details here, but involved the same type of incubations than the main experiment. The variables measured in these incubations were DIC/Alkalinity, pH, salinity and chlorophyll *a* (Chl *a*).

The water was collected in 5L acid-cleaned collapsible bags at station P4 and at station PAPA from 5m and 10m depths, respectively, with a diaphragm Teflon-pump in a trace-metal clean hood. After receiving their iron addition, the bags were incubated for 48 to 96h 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 was taken every day during the incubation time. The following variables were monitored at T0, T24, T48 and T96: Chl *a* concentrations, nutrients, phytoplankton enumeration and identification, bacteria enumeration, photosynthetic efficiency (Fv/Fm ratio), dissolved iron and iron speciation, particulate organic carbon (POC) and particulate organic nitrogen (PON), dimethylsulfoniopropionate (DMSP) concentration, and DMS concentration. Sub-sampling of the incubation bags took place inside a trace-metal clean laminar flow hood located in the radvan. Furthermore, 1L bottle incubations were run in parallel to the bag incubations to determine rates of primary production ($K^{15}NO_3$ – $H^{13}CO_3$). Samples of DMS, Fv/Fm and Chl *a* were analyzed onboard the ship within hours of collection. The remaining samples will be brought back either to IOS, UVic, UBC or Université Laval in Quebec City for analysis.

The whole experiment ran smoothly though some adjustments had to be made at first such as a downscaling of the treatment number at PAPA. Thanks to the great coordinating skills of our Chief Scientist Marie Robert, the schedule and timing of the different steps of our work were ideal. Pumping the water in the early-morning allowed us to work during daylight, which is crucial to the planktonic cells (and much appreciated by the team!). This is a great improvement compared to last year. A very positive point also was our setting in the radvan, which allowed us to have plenty of counter and storage space, have access to flowing seawater and be close to the incubators, which makes the transportation of the incubation bags less burdensome. On that note though, I would like to mention that one morning, the radvan got mistakenly locked, and nobody had the key on board. We had to saw through the lock. I would suggest that both the main responsible of the project and somebody from the crew possess a key to the radvan for all cruises to prevent such a situation.

We would like to gratefully thank many people that made this cruise and project not only possible but greatly enjoyable. First, we would like to thank our Chief Scientist Marie Robert for her generosity, flexibility and appreciated efforts to accommodate our needs. You made miracles fitting all of this work in such a tight schedule and keeping people happy in the process, thank you! We are also grateful to Keith Johnson for operating the Teflon-pump and measuring pH of course, but also so much more. Thank you for your precious help, advices, material, labspace, time, patience and above all, your seemingly endless kindness. We would like to thank Michael Arychuk who measured in a (very!) timely manner our DMS samples. Thank you for keeping up with our uneven schedule, thank you also for your pre-cruise help, welcoming and orienting me at IOS, and continuously being so accommodating with us. We are also very grateful to Darren Tuele for setting us up with these beautiful and sturdy new incubators. Thank you to all of our collaborators at IOS, UVic and UBC who will be measuring variables in our samples at our return to shore. We are thankful to all fellow scientists onboard for the good times we shared, with special thanks to Constance Couture for her punctual help with our daily chores and analysis. And finally, last but not least, thank you to Captain Quaye and the CCGS John P. Tully red crew. Your hard work, kind help and cheerful willingness to make our work easier was greatly appreciated. Thank you to the cook and second cook for the wonderful food, thank you to our stewards for welcoming us with a smile every morning and keeping our living space so well maintained. Thank you to every member of the crew for making us feel welcome aboard, making this cruise so enjoyable and leaving us with good memories.

^{234}Th, ^{230}Th and ^{231}Pa (dissolved and particulate) in the upper 1600m at station P26

R. Francois, M. Soon, Y. Luo, D. Yelland

We have collected samples for dissolved and particulate 230Th and 231Pa at 12 depths and samples for dissolved and particulate 234Th at 20 depths within the upper 1600m at station P26. The purpose is to develop a new approach to estimate particle flux and remineralization/dissolution profiles in the mesopelagic zone of the ocean. Most of our sampling program was successfully completed. We also collected samples for 230Th and 234Th with a multinet vertical tow in an attempt to measure the concentration of 230Th and 234Th associated with large sinking particles over a range of depths.

1 - Dissolved 230Th and 231Pa

We did two shallow hydrocasts tripping 6 bottles at each depth (20, 60, 100, 200m) to collect 60L samples.

Samples from the first cast were immediately filtered through a 0.45um “Polycap GW” (Whatman) with a peristaltic pump into 20 L cubitainers, acidified with HCl to pH 2 and stored for subsequent processing and analysis in the shore laboratory.

Samples from the second cast were immediately filtered through a 0.45um “Polycap GW” (Whatman) with a peristaltic pump into 20 L cubitainers, acidified with HCl to pH 2 and transferred into 100L totes where they were spiked with 229Th and FeCl3. They were left to equilibrate for 24 hours before bringing the pH to ca. 8.5 with NH4OH to precipitate Fe(OH)3 and scavenge 230Th and 229Th from seawater. The Fe(OH)3 was allowed to settle to the bottom of the tote over a 24 hour period before using a peristaltic pump to remove the supernatant. The Fe(OH)3 was recovered in a small volume of water and centrifuged. The samples where then returned to the shore lab for subsequent processing and analysis.

We did two deep hydrocasts tripping 6 bottles at 300 and 400m to collect 60L samples and 2 bottles at 600, 800, 1000, 1200, 1400, 1600m to collect 20L samples. The 60L samples from the first and second cast were processed as described above. For the 20L samples, precipitation and decantation were carried on in 20L cubitaners instead of 100L totes.

2 - Particulate 230Th and 231Pa

We collected marine particles with 3 large volume in-situ pumps. Each pump was mounted with two 120mm diameter filter holders to collect small suspended particles on Tissue-Quartz (0.8 um pore size) and Supor (0.8 um pore size) filters simultaneously. A leak in pump head number five resulted in overestimating the volume passing through the tissue quartz filters of pump 5. A 63 um Nylon mesh was also placed on top of each

filter to collect large sinking particles. Because of the leak in pump head 5, the filter holder with the Supor filter could not be drained before recovering the Nylon mesh and the samples were lost.

We successfully recovered 12 Supor filters for 230Th, 231Pa, 234Th, P, Ca and Al analysis (20, 60, 100, 200, 300, 400, 600, 800, 1000, 1200, 1400, 1600m); 8 Tissue-Quartz filters for 234Th, organic carbon, N analysis (60, 100, 300, 400, 800, 1000, 1400, 1600m); 8 Nylon mesh samples for 234Th, 230Th, 231Pa, P, Ca, and Al. The volumes filtered are given in the table below. The tissue-quartz and supor filters were dried in an oven at 60C. The mesh samples were frozen.

depth(m)	pump#	Pumping time	Vol - Supor (L)	Vol - TQuartz (L)	Vol - Mesh L)
20	5	3:57	202.3	655.3	
60	6	2:23	339.5	256	595.5
100	7	3:55	755	598.8	1353.8
200	5	3:12	848	661.2	
300	6	4:00	1022.6	509.9	1532.5
400	7	2:59	745.8	359.4	1105.2
600	5	4:00	967.3	640.7	
800	6	4:00	1250.3	314	1564.3
1000	7	4:00	1130.1	437.9	1568
1200	5	4:00	944.5	637.1	
1400	6	4:00	1231.1	302.7	1533.8
1600	7	2:17	715.9	198.4	914.3

Tissuquartz volumes for 20m,200m,600m,1200m are overestimated
as a result of Pump head 5 leaking

Because large sinking particles are very rare in the water column, it is very difficult to obtain a statistically meaningful sample by pumping. We therefore took advantage of having a multinet on-board to assess this technique as a means of collecting large sinking particles from a larger volume of water. The samples will be analyzed for 230Th, 231Pa, 234Th and Al. The presence of “swimmers” in the samples prevents us from measuring carbon in the sinking aggregates. This should not be a problem for the isotopes of interest, since they do not accumulate in living tissues. In future experiments we will decrease the rate of ascent of the nets to allow swimmers to escape. This may allow us to collect only passively sinking aggregates.

Net mesh size: 236um

Depth range	Volume
1600-1200m	119 m3
1200-800m	111 m3
800-500m	84 m3
500-200m	84 m3
200-0m	61 m3

Samples were preserved with HgCl2 (200 ul; ## mg/L) and stored at 4C before analysis

3 - Total and particulate 234Th

Depth (m)	Vol for part.	
10	5.0;5.0	two bottles for duplicates
20	5.0;5.0	two bottles for duplicates
40	6.0;6.0	two bottles for duplicates

60	6.0;6.0	two bottles for duplicates
80	6.0	
100	7.0	
125	7.0	
150	7.0	
175	6.5	
200	7.0	
250	7.0	
300	7.0	
350	7.0	
400	7.0	
600	6.8	
800	7.6	
1000	7.0	
1200	7.0	
1400	7.0	
1600	7.7	

24 samples were collected between 10 and 1600m depth:

3.1 - Particulate 234Th samples:

~6L were measured with a graduated cylinder and filtered on 25mm tissue quartz (1um). The filtered seawater was water discarded and the filter dried in an oven at 50°C for 2hours) for subsequent beta counting

3.2 - Total 234Th samples:

2L of seawater were measured with a graduated cylinder and poured in a 2L Nalgene bottle. HCl 2N was added to pH 2 with 230Th as spike. After 12 hours of equilibration, pH was adjusted to 8 with NH4OH before adding KMnO4 and MnCl2. Afer 1 hour equilibration, the solution was heated in a water bath to 80C for 1 hours. After cooling, the MnO2 precipitate was collected by filtration on tissue quartz, dried at 50C and mounted for subsequent beta counting.

Neodymium isotopes in filtered seawater at station P26
R. Francois, M. Soon, Samples for A. Snauffer

We have collected samples to measure the Nd isotopic composition of filtered seawater at P26. The purpose of the study is to elucidate the processes whereby seawater acquires it Nd isotopic composition and whereby seawater Nd isotopic composition is transmitted to marine sediments. The overarching goal is to develop Nd isotopes as a reliable tracer of past changes in ocean circulation.

20L samples were collected at 12 depths: 10, 100, 250, 500, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 10m off the bottom.

Samples were immediately filtered through a 0.45um “Polycap GW” (Whatman) with a peristaltic pump into 20 L Jerrycans, acidified with HCl to pH 2 and stored for subsequent processing and analysis in the shore laboratory.

Collection of foraminifera with multinet at station P26
R. Francois, M. Soon, D. Yelland; Samples for B. De Baere

A multinet cast was performed in an attempt to collect foraminifera and measure the Mg/Ca and Sr/Ca ratio of their shells in relation to ambient temperature and salinity.

Net mesh size: 236um

Depth range
25-0m
50-25m
75-50m
150-75m
500-150m

Samples were preserved with??? and stored at 4C before analysis

Collection of filtered seawater at station P26
(R. Francois, M. Soon, Y. Luo)

100L surface water (20m) were filtered through a 0.45um "Polycap GW" (Whatman) with a peristaltic pump into 20 L Jerrycans to conduct culture experiment in the shore laboratory.

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 was measured 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. Fluorescence and backscatter will be measured with a Wetlabs ECOFLNTU. Additionally, we deployed a SAMI pH sensor. All sensors will communicate with the NOAA-PMEL MAPCO$_2$ system and report data in real time.

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. The help I received not only made all of my data collection possible but made the cruise enjoyable.

NOAA/PMEL – Station Papa Moorings – K. Ronnholm, M. Craig

Summary of Mooring Operations

Nominal Site	Mooring ID #	Operation
50N 145W	PA004	Deploy
50N 145W	UW/APL Waverider	Deploy
50N 145W	NP003	Recover
50N 145W	PA003	Recover

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 2010-13 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 the PAPA-2010 (PA004) surface mooring and recovered the similar surface mooring (PA003), deployed from the *Tully* in June 2009. The subsurface ADCP mooring NP003 was recovered and a wave measurement buoy was deployed.

Staging and assembly of the buoy at IOS went very smoothly thanks to the assistance of the IOS Winch Shop – Roger and Luke. We are grateful for the opportunity to assemble the buoy under the IOS shed, which kept our instrumentation dry during the rain and cool weather. Their assistance in loading the equipment was also invaluable. The majority of our lab equipment was craned to the Bridge deck, and hand carried into the hydrographic chart room. This space was comfortable for our purposes; it provided adequate space for setup and an instrument check-out. And it was close to the antennas mounted two decks above on the "Monkey bridge". The stowage arrangements on deck worked fine with the new PAPA mooring tied down just forward of the crane on the starboard side.

After high seas and strong winds on June 11th and 12th, the seas calmed sufficiently by Monday June 14th, the first full day at PAPA, for the successful deployment of the new surface mooring PA004. Since we had a forecast of calm winds and seas for the full 4 days at PAPA, only one mooring operation was scheduled each day.

We began at 0730 to set up the deck, talk through the deployment sequence, lay out the wire, and mount instruments. The surface float was deployed off the starboard side forward of the crane. We worked throughout the day attaching sensors to the wire, spooling out nylon, with anchor drop at 1514 PDT. We were close enough to the buoy after the drop to watch it racing across the surface, leaving a wake. The captain reported it moving at 5 knots, The deployment went very smoothly, with no issues. The final position of PA004 is 50°N 02.8431N, `44° 52.9207W. The mooring has dual meteorological instrumentation and data transmission systems, subsurface temperature and conductivity sensors to 300 m, a pCO2 measurement system, with pH and oxygen/gas tension measurements at 1 m (see Seth Bushinsky's section for details), and a downward looking ADCP mounted on the bridle. All systems are functioning well and transmitting data back to Seattle.

The Applied Physics Lab of the University of Washington provided a Waverider mooring which was deployed on 15 June to provide real-time measurements of ocean waves. Work again began at 0730, and the anchor drop was at 1411 PDT, with a final position of 49°N 59.121N, 145° 05.034 W. Data from this new mooring is available at http://cdip.ucsd.edu/?nav=recent&sub=observed&units=metric&tz=UTC&pub=public&map_stati=1,2,3&stn=166&stream=p1&xitem=pm

and it has been reported that everything is working beautifully and full data is being transmitted. The buoy is now considered station 46246 by the US National Data Buoy Center.

The subsurface ADCP, NP003, was recovered on Wed 15 June. This mooring is a collaboration with NOAA/PMEL, University of Washington – Applied Physics Lab (APL), and the University of Victoria all providing components. After the release was fired at 0818 PDT, it was initially difficult to locate the first float, but with the assistance of the RF beacon, about 20 minutes after the release we spotted the first float. About 10 minutes after that we saw the second ADCP float, about 50 m from the first one. And about 45 minutes after the release was fired, the yellow glass balls at the bottom of the mooring appeared, again about 50 m away from the second float. (50°N 06.88 N, 144° 58.26 W). The small boat was used to attach a tow line to the top float, and passed to the Tully. We towed for about 10 minutes to stretch the mooring out since the floats all came up near to each other. Then the Tully was maneuvered into a position where a line from the crane could be hooked onto the float. The float was brought onboard by the crane. The wire was brought onboard via a block on the A-frame and the capstan, and all instruments were recovered. The second ADCP float ball was on deck at 1120 PDT. After 2 hours of spooling Kevlar, the float balls and release tandem were brought on board at 1324 PDT. There were no issues with overheating hydraulics which had impacted the NP002 recovered in 2009.The data from the recovered instruments will be processed over the next several months.

The NP003 surface mooring recovery operation was started at 0730 Z on 17 June 2010 with on-deck preparations and setting up the ORE acoustic release transducer. Weather was overcast with winds 12 knots and low swell – the ADCP recovery was done on 16 June to allow the NP003 recovery under the even calmer conditions on the 17th.

The acoustic release at the bottom of the mooring would not provide a response, even with the prop declutched and the sounders disabled. At one point during the 1.5 hours of trying (0900-1030 PDT)), we even stopped the ships engines. There was no response from the release. The mooring was located at 50°N 07.2N, 144° 48.6 W. The buoy remained in place, even after repeated release codes were transmitted, so we proceeded, assuming the mooring was still connected to the anchor.

The small boat was used to attach a tow line to the buoy, and it was passed to the Tully. The buoy was hauled in to within 15 feet of the stern. Two tag lines were attached by the personnel in the small boat. A lifting strap was choked on the t-cup handle, and a line from the crane was lowered and connected to the lifting strap by the coast guardsmen in the small boat. The crane lifted the buoy from the water, tower in towards the stern. The float was brought onboard at 1115 by the crane. No sensors were damaged and all Flex, Atlas and CO2 sensors and systems were recovered. Without using DP, the officers of the Tully did a superb job of ship handling.

The buoy is in good shape, with some algae growth on the top, and an extensive crop of barnacles on the bridle and bridle instruments. The CO2 equilibrator was not damaged during the recovery. The wire was brought onboard via a block on the A-frame and the capstan, and ALL instruments were recovered. There were no barnacles below 20m and no evidence of fishing.

The complete wire (325m) was recovered, and since the tensions still seemed low, we began recovery of the 1156m piece of nylon. For most of that large spool, tensions seemed low and we successfully completed that spool. The tension was greater at this point and it was decided in the interest of safety to abort recovery of nylon at this point. The remaining nylon was attached to a quick release on the crane wire, and released at 1237 PDT. Four spools of nylon, a shorter cut piece, and the release were lost.

The ship departed Station Papa/P26 in the evening after 4 full days 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. 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.

We are especially grateful for the excellent support provided by the Captain and Crew of the *CCGC John P. Tully*. Captain Andy Quaye provided excellent communication, including numerous weather forecasts, and was very supportive of our mooring work. The ship handling by the Captain and Second Officer Shane Lovelace was precise and enabled the successful, and safe, recovery of all sensors undamaged.

The Chief Officer, Don Gibson's experience and keen safety eye were evident on the back deck. The deck crew, led by Boatswain Randy Sanderson, did an excellent job during all mooring operations and was very willing to listen to suggestions. Operations were conducted safely, calmly, and he expertly controlled the deck while calmly leading a relatively inexperienced deck crew. The crane was operated skillfully by Leading Seaman Piper Harris. Seaman Matthew Lahaise was very skillful in boat handling during the close-in maneuvering needed for the ADCP and surface float recoveries. Seaman Michael Carey's work in securing lines to the buoy from the small boat earned him a few bruises, and his helpful demeanor on deck made working on deck much easier.

Seaman Jesse, Zack, and Ryan were all very helpful and eager to help with the operations – and any time it was needed.

And a special thanks to the cooks (Sam and Doug) and stewards (Megan and Kris) for the excellent food and cheerful service.

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

Jody Wright, Karl Schiffmacher and Constance Couture (UBC) Line P – June 2010

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 (20L) 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 (also done at a 6th station – P8); and 3) measure the bacterial abundance and the concentration of greenhouse gases (CO_2, CH_4 and N_2O), as well as nitrite (NO_2), thiosulfate (S_2O_3), and ammonia (NH_3) along a 16 depths vertical profile.

At one of the major stations (Station Papa) we collected viral particles as well as bacterial cells from the seawater samples of several depths for Elke Allers and Jenn Brum from the University of Arizona 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 to continue measuring nutrients and chemistry (ammonia, thiosulfate and nitrite) our group would continue to require a 3rd berth. 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. 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.

RADIOISOTOPE USE:

No radioisotopes were used during this cruise.

PROBLEMS [SCIENTIFIC GEAR AND OPERATIONS]:

We still have some problems with the main CTD data acquisition computer. It used to reboot during casts, while the CTD was in the water. It doesn't reboot anymore; it simply freezes, and we have to reboot it in order to complete the cast. This problem really should be solved.

We also had problems with Niskin 1 on the rosette not closing a lot of the time. The same problem occurred during the previous cruise (La Perouse, 2010-12). Sometimes the latching mechanism unlocked but the Niskin closed only at the surface or once on deck. Other times the latching mechanism was simply not unlocking. The latching carrousel was swapped twice but the problem persisted. There seems to be a problem with the way Niskin 1 lines up with the mount of the rosette. This should be addressed.

The fridge/freezer in the Rad-Van does not freeze very well. Samples that were frozen in a different freezer will stay frozen once transferred to the Rad-Van freezer, but it is not cold enough to freeze the samples initially.

The serial number of the sensors used on the CTD should be written in big numbers in a visible spot on the sensors so that the first page of the logbook can be filled in with more confidence. Once the CTD is in the rosette frame it is practically impossible to read the serial numbers of the sensors.

SUCCESSES [SCIENTIFIC]:

All the mooring work was completed, and it all went smoothly. Unfortunately one acoustic release stayed silent (see NOAA report), but all the work got done without any incident.

We spent over 4 days at Station Papa and the surrounding areas (mooring sites) and performed 28 casts of different types during that time (including mooring deployment/recovery).

Thanks to Doug Yelland for taking the time for fuelling during the La Perouse cruise so that we did not have to fuel at the beginning of Line P.

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

The Tully-ScienceLab account was still not working properly when we lost internet access. Thanks to Doug Yelland for setting it up.

SUCCESSES [SHIP]:

The LARS worked beautifully. We did all casts from the mid-ship station and did not have to reterminate a single time.

We also had no problem with the loop system, despite having three big incubators on the heli-deck.

DELAYS [OTHER THAN WEATHER]:

About one hour to help the *CCGS Bartlett* in Saanich Inlet.
About eight hours for medical emergency just off Victoria.

SAFETY CONCERNS:

None.

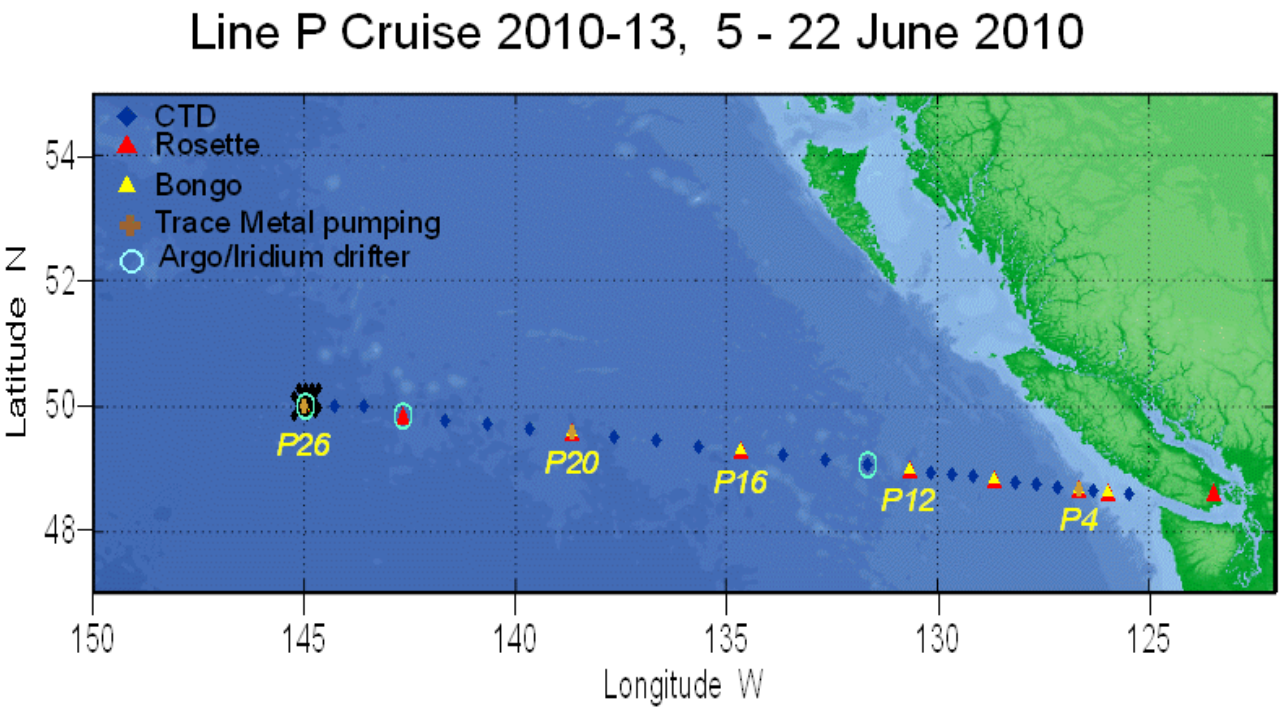
HAZARDOUS OCCURRENCES:

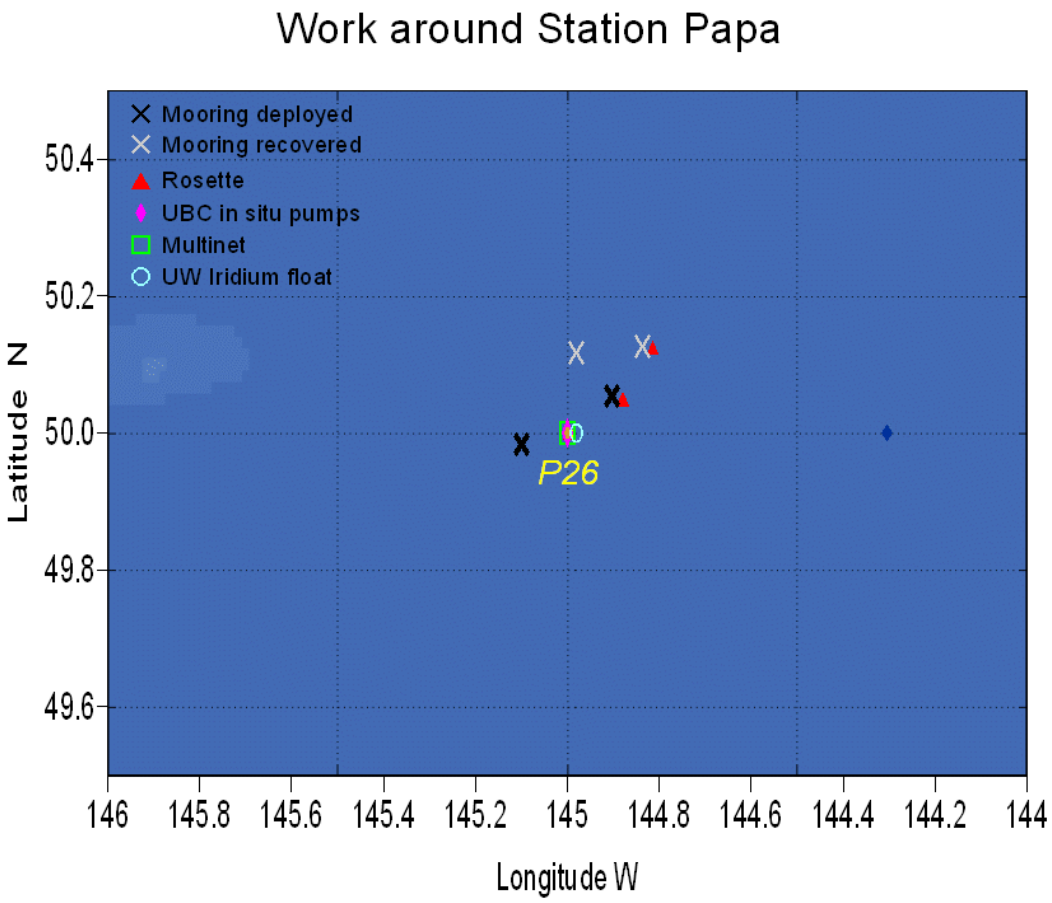
None involving science personnel.

EVENT LOG:

DATE		OPERATIONS
Saturday	**5 Jun:**	**Start loading the ship at IOS. Test cast in Saanich Inlet. Leave Pat Bay.**
Sunday	**6 Jun:**	**Medical emergency. Start Line P.**
Friday	**11 Jun:**	**Complete station P21, go straight to P26 because of storm.**
Sunday	**13 Jun:**	**Arrive at Station Papa. Day of Rosette casts.**
Monday	**14 Jun:**	**Deploy PA-003. Rosettes, *in situ* UBC pumps, bongos cast**
Tuesday	**15 Jun:**	**Deploy Wave Rider mooring. *In situ* UBC pumps, bongos cast.**
Wednesday	**16 Jun:**	**Recover ADCP mooring. Rosettes and multinets.**
Thursday	**17 Jun:**	**Recover PA-003 mooring. Rosette cast and multinet. Deploy UW float. Depart Station P and start doing missing CTDs**
Friday	**18 Jun:**	**All stations complete.**
Monday	**21 Jun:**	**Arrive at IOS and offload.**

CRUISE TRACK:





SUMMARY/FINAL COMMENTS:

- Thanks to **everyone** on board for such a successful cruise. EVERYTHING went well.
- Many, many thanks to the whole galley crew. Despite some changes in the crew at the beginning of the cruise, the food was always fantastic during the entire cycle and the service always amazing. Sam you really did a wonderful job, thanks! And thanks too for the traditional barbecue at the end of the cruise. It sure is the best way to celebrate all together 28 days of hard work well done!
- Welcome back to Captain Quaye! Many thanks for your constant look at the weather and your amazing weather calls; to change the order of mooring recoveries on the last two days at Station P probably help avoid lots of stress! Thank you also for using two engines when needed to pick up the time lost at the beginning of the cruise.
- Welcome back also to Chief Horton. It was sad to see Mark Decker go, but I feel that we still are in very, very good hands!
- Matt: glad you were ok! ☺
- Thanks to Keith Ronnholm for volunteering his amazing talk on Mt. St. Helens, that was great!
- Thanks to everyone at IOS who helped getting this cruise ready: Janet, Wendy, Nina, Marty, Glenn, Melissa, Kelly, Scott, Phil and his team, *et al*!
- Thanks to the deck crew and the engineering department for their constant help with our daily “little issues”.
- Finally, thanks to the whole Red Crew for three great Papa cruises since last August. Wishing you happy and smooth sailings, and we’ll see you all again in August 2011 for another Line P adventure!