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:** 7 June 2015 **TO:** 23 June 2015

SCIENCE CRUISE NUMBER: 2015-09 **SHIP'S PATROL NUMBER:** 15-03

CHIEF SCIENTIST[S]: Marie Robert

SCIENTIFIC PERSONNEL:

Female	Male
Natalie Cohen (UNC)	Michael Arychuk (IOS)
Jennifer Keene (NOAA)	Mark Belton (IOS)
Céline Michiels (UBC)	Glenn Cooper (IOS)
Marie Robert (IOS)	Michael Craig (NOAA)
Jade Shiller (UBC)	Niko Finke (UBC)
Amanda Timmerman (UVic)	Benjamin Twining (U. Maine)
Mariela White (UW)	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.

CRUISE OBJECTIVE/OBJECTIVES: Repeat hydrography section (physics, chemistry, zooplankton), deploy 10 weather data drifting buoys for NOAA, service NOAA moorings.

CRUISE DESCRIPTION: This cruise (2015-09) was a success despite some strong winds at the beginning of the cruise. We had to cancel a few casts but we were able to visit these stations on the return leg. The mooring work at Station P went really well. The weather was good and all operations went very smoothly. Both the deployment of mooring PA-009 and the recovery of mooring PA-008 were total successes. The pumping in the chains also went well despite some heavy winds at P4 and a few problems with some kinks in the clean hose. Most casts that had to be performed at a specific time with respect to the sun position were done at the right time. While we were offshore an important algal bloom was detected along the coast of North America. We were asked to do a few extra casts upon our return in coastal waters to verify the extent of the bloom in Canadian waters.

DAYS ALLOCATED: 16 **DAYS OF OPERATION:** 15

DAYS LOST DUE TO WEATHER: about 6 hours between P4 and P8. Also some 4 stations were cancelled at the beginning of the cruise because of weather and done on the way back.

SAMPLING:

- The Line P survey was 100% successful. All planned stations were visited and all planned profiles got done. We also revisited two Line P stations (P4 and P2) and 10 LaPerouse stations along the inshore end of the "LB" and "LC" lines to investigate an important algal bloom present along the coast.
- Ten weather data drifting buoys were deployed for NOAA.
- The samples collected include:
  1) Underway: **IOS**: Thermosalinograph (Temperature, Salinity, Fluorescence), acoustic sounder, ADCP, pCO_2, irradiance off the heli-deck.
  2) "E-data" from CTD: Pressure, Temperature, Conductivity, Dissolved Oxygen, Transmissivity, Irradiance, Fluorescence.
  3) From the Rosette: **DFO-IOS:** dissolved oxygen, salinity, nutrients, DMS, DMSP, chlorophyll, pigments (HPLC), dissolved inorganic carbon (DIC), alkalinity, pH, micro-plastics – **UBC (Schiller):** number of cells per millilitre, virus counts, bacterial genomic (DNA, RNA) and sequencing – **UBC (Michiels, Finke):** N-species, respiration rates, nitrogen cycle process rates measurements (15N-labeled incubation), sulfide oxidation rates, CH4 and methane production rates, gases – **UVic (Timmerman):** ONAr (Oxygen, Nitrogen, Argon), dissolved oxygen, triple oxygen, ammonium, nutrients, chlorophyll, ^{17}O, salinity **– UW (White):** ONAr, ^{17}O, DIC, alkalinity, salinity.
  4) **DFO-IOS (Yelland):** Zooplankton using vertical net hauls (Bongos to 250 m and 1200 m) and Multinet to 3000 m.
  5) From the Trace Metal pump: **UNC and U.Maine (Cohen-Twining):** Dissolved and total dissolvable iron and other trace metals, Chl, RNA, Cell counts, biogenic silica, nutrients, C13/N15 uptake (primary productivity), iron quotas.

RADIOISOTOPE USE:

No radioisotopes were used during this cruise

PROBLEMS [SCIENTIFIC GEAR AND OPERATIONS]:

We used the "new" label laptop and label printer. Either because of the ink or because of the labels, the ink wasn't staying on the labels. Some labels were really hard to read after being handled. Hopefully the numbers can still be identified at the time of processing samples. Also the label laptop needed constant rebooting. Even though only the label software and Excel were being used on that laptop, we kept getting a "low memory" error message and part of the screen would be black.

The TSG pond filter is not practical. The fluorescence signal kept increasing during the cruise as plankton grew in the filter. We tried to take the filter apart to clean it but it was too big of a task. The filter gets really heavy and the plankton is stuck to the foam. Also unless we take it all apart we don't know when the filter needs cleaning. We now suspect that the inside of the fluorometer casing itself might be covered in growth since, even after bypassing the filter, the fluorescence signal remained very high and actually kept increasing until the end of the cruise when it reached the maximum value for the gain cable used. We need to go back to a system where A) the growth inside the filter is visible and easily accessible, and B) we can clean the fluorometer daily. (See science section for more details). Towards the end of the cruise the metal elbow connecting the big black hose to the manifold broke, the metal being too corroded. This piece should have been made of plastic like all other connectors. Thanks to Michael Arychuk for his help in fixing it.

The CTD acquisition software shut itself off twice during CTD casts.

SUCCESSES [SCIENTIFIC]:

Most of the lab computers (science server, ADCP, AVOS, EK60 and EA600) worked flawlessly.

The loading and offloading of the science gear went very smoothly, with everyone participating and helping.

The Milli-Q water was clean during the whole cruise with no signs of contamination (see science report).

We tried a new model of dispenser for the mercuric chloride (DIC poisoning) and it worked much better than the old one. We now just need a higher cooler to be able to carry it safely.

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

There is a very loud high pitch noise affecting many cabins every time the bow thrusters are in use.

The main CTD winch was not spooling properly. We had to stop during almost all "upcasts" for casts deeper than 1000 m and go back down for quite a few metres to correct the spooling.

Many radios were not working properly and communication was really challenged between the bridge, the LARS cab and the Closet during some casts. The microphone of the ship radio in the main lab completely stopped working the last day at Station P.

SUCCESSES [SHIP]:

The network worked flawlessly, no computers were randomly kicked off the network and all science email accounts worked fine as well.

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

The turn-around between the La Perouse cruise and Line P was done very efficiently, allowing us to leave at such a time that the "sun sensitive" casts could be done at the necessary time at P4, without having to wait for 18+ hours on station.

DELAYS [OTHER THAN WEATHER]:

A few hours because of the main CTD winch spooling issues.

SAFETY CONCERNS:

None.

HAZARDOUS OCCURRENCES:

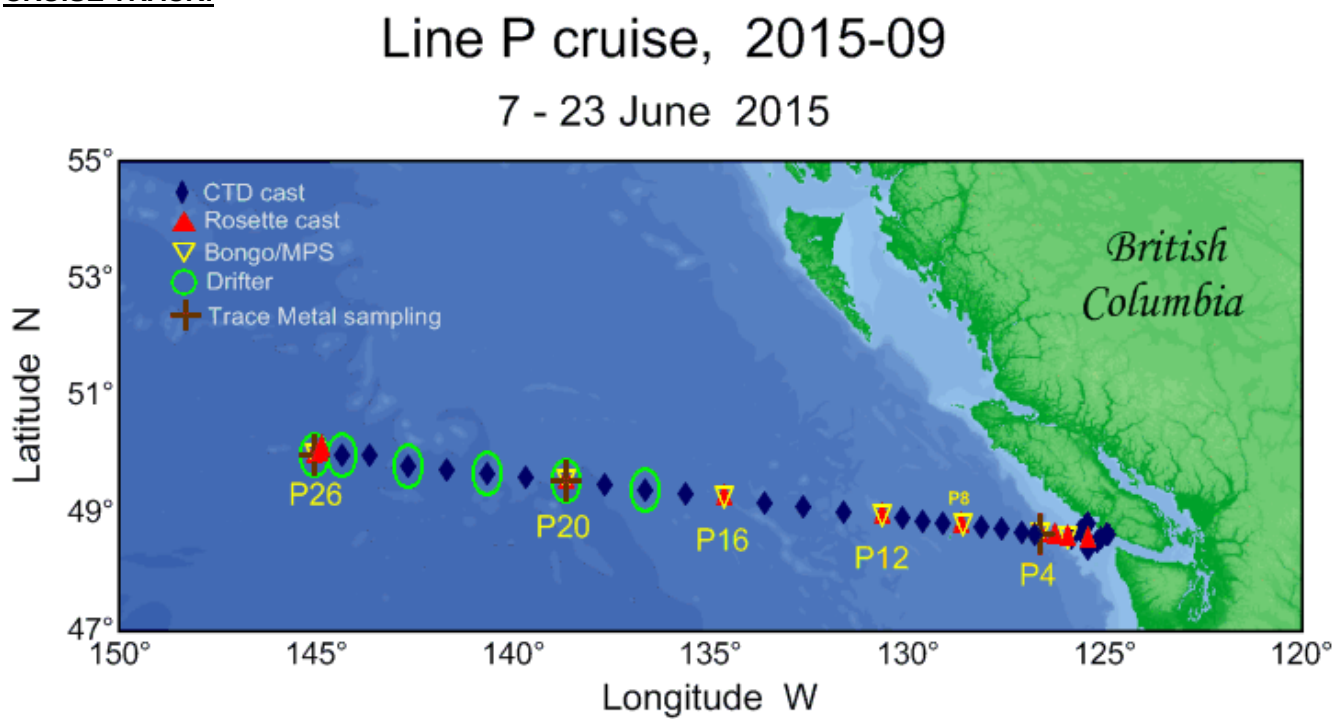
None involving scientific personnel.

EVENT LOG:

Sunday 7 June:	Start loading the ship at IOS around 0800. Safety meeting at 1600. Leave IOS at 1815. Proceed to P1. Science meeting at 1900.
Monday 8 June:	Fire and boat drill at 1300. Stations P1 to P4.
Tuesday 9 June:	Complete station P4. Cancel ONC, P5, P6, P7 b/o weather. Do Rosette at P8 but cancel P8 bongo.
Wednesday 10 June:	Stations P9 to P12.
Thursday 11 June:	Stations P12 to P15. First "mooring meeting".
Friday 12 June:	Stations P16 to P18. Deploy one NOAA drifter at P18.
Saturday 13 June:	Stations P19 and P20. Deploy one NOAA drifter at P20.
Sunday 14 June:	Stations P21 to P24. Deploy two NOAA drifters at P22 and two at P24. Fill-in 2 large "cubes" and one drum with surface bulk water at P22 and P23. Calibration cast at P23. Second mooring meeting.
Monday 15 June:	P35. Station Papa Day 1. Deploy PA-009 mooring. Calibration cast at PA-009. PAR cast, Deep cast and Niko's cast at P26.

Tuesday 16 June:	Papa Day 2: Pumping in the chains. Calibration cast at PA-008. Recover PA-008 mooring. PAR, Céline's, Jade's, and plastics casts.
Wednesday 17 June:	Papa Day 3: Amanda's cast. Bongo to 250m. Multinet to 3000. DMS cast. Start sailing east.
Thursday 18 June:	Sailing east.
Friday 19 June:	Sailing east.
Saturday 20 June:	Stations P8 to P4, plus ONC.
Sunday 21 June:	Stations P2, LC06, LC04, LC02, LC01, P1/B8, LB08, LB06, LB04, LB02, LB01.
Monday 22 June:	Dock at IOS and offload.

CRUISE TRACK:



SUMMARY/FINAL COMMENTS:

- Many thanks to everyone at IOS who have helped make this cruise a success: Kenny, Nina, Kelly, Moira, Tamara, Darren … your help is always greatly appreciated!

- Welcome back to Captain Gibson. It was a real pleasure to sail with you again, and I sure hope that this was not the last time! Come back soon!

- And thanks to everyone on board for such a successful and enjoyable cruise! Special thank you to Alex for an amazing barbecue, and to Bruce for such smooth mooring work. Hoping to see you all again in August 2016!

  Marie Robert and the science team.

- I'd like to thank the captain and crew of the *Tully* for their assistance and excellent work throughout the cruise. Thanks to the IOS team and the scientists onboard for their help and their humour on deck and in the lab. And finally, a great big thank-you to Marie for patiently answering my numerous questions while I got my sea legs on my first Line P cruise.

  Jade Schiller

- Thank you to the Captain, officers and crew of the JP Tully for making the cruise productive. I also want to thank IOS personnel for their help sampling, filtering and analyzing samples. Many thanks to the science crew. Thank you especially to Marie Robert for her support and accommodating my sampling requests, Mariela White and Mark Belton for their help with sampling, Doug Yelland for his help with the

PAR casts, and Glenn Cooper for his help with the incubators. I want to thank Sarah Thornton for allowing me to borrow equipment.

Amanda Timmerman

- We thank Marie for the help accommodating all our various needs to perform our work. We thank Mike for the help getting the gas bottles onto the ship as well as general organization and Mark for the help sampling. We also thank the entire white crew of the John P. Tully for the support making this work possible.

  Céline Michiels and Niko Finke

- We thank the 2015-09 Line P scientists of IOS for their generosity and guidance, the officers and crew for their shipboard assistance, and the remaining members of the scientific party for their continued support. This work is supported by the National Science Foundation (NSF) under grant NSF OCE-1334632 to Adrian Marchetti and Ben Twining.

  Natalie Cohen and Ben Twining

- On behalf of Steven Emerson lab at the School of Oceanography UW, we would like to sincerely thank the officers and crew of CCGS John P Tully for all their hard work and invaluable assistance. Special thanks to chief scientist Marie Robert for being accommodating, arranging specific times for the calibration casts, and for being overall awesome to work with. Thank you IOS scientists for assisting with deployment/recovery day, overseeing rosette casts, and moral support. Thanks also to Amanda Timmerman of UVic for assisting with calibration cast sampling, and for scraping tape off our instruments. Line P cruises are always a great experience in collaboration and cooperation between the different ocean science institutions.

  Mariela White

- The replacement NOAA mooring was safely deployed, and the existing mooring was successfully recovered. Project PI Meghan Cronin sends her sincere thanks to the captain and crew of the TULLY, and to IOS, for the continued partnership, hard work, and cooperation that make this ocean reference station mooring at Station P possible.

  Jennifer Keene and Michael Craig

PROJECTS AND RESULTS:

Water masses – Marie Robert, DFO/IOS.

The main story of the last couple of years in terms of conditions in the Pacific ocean was the very large mass of warmer-than-usual water situated in the top 100 metres or so, and covering most of the Gulf of Alaska. Again on this cruise one big question to answer is if the warm water is still there? When looking at the anomaly of temperature with respect to the 1956-1991 averages, it seems that the answer is yes. Figure 1 below shows the evolution of temperature anomaly from August 2013 to June 2015 with respect to the 1956-1991 averages:

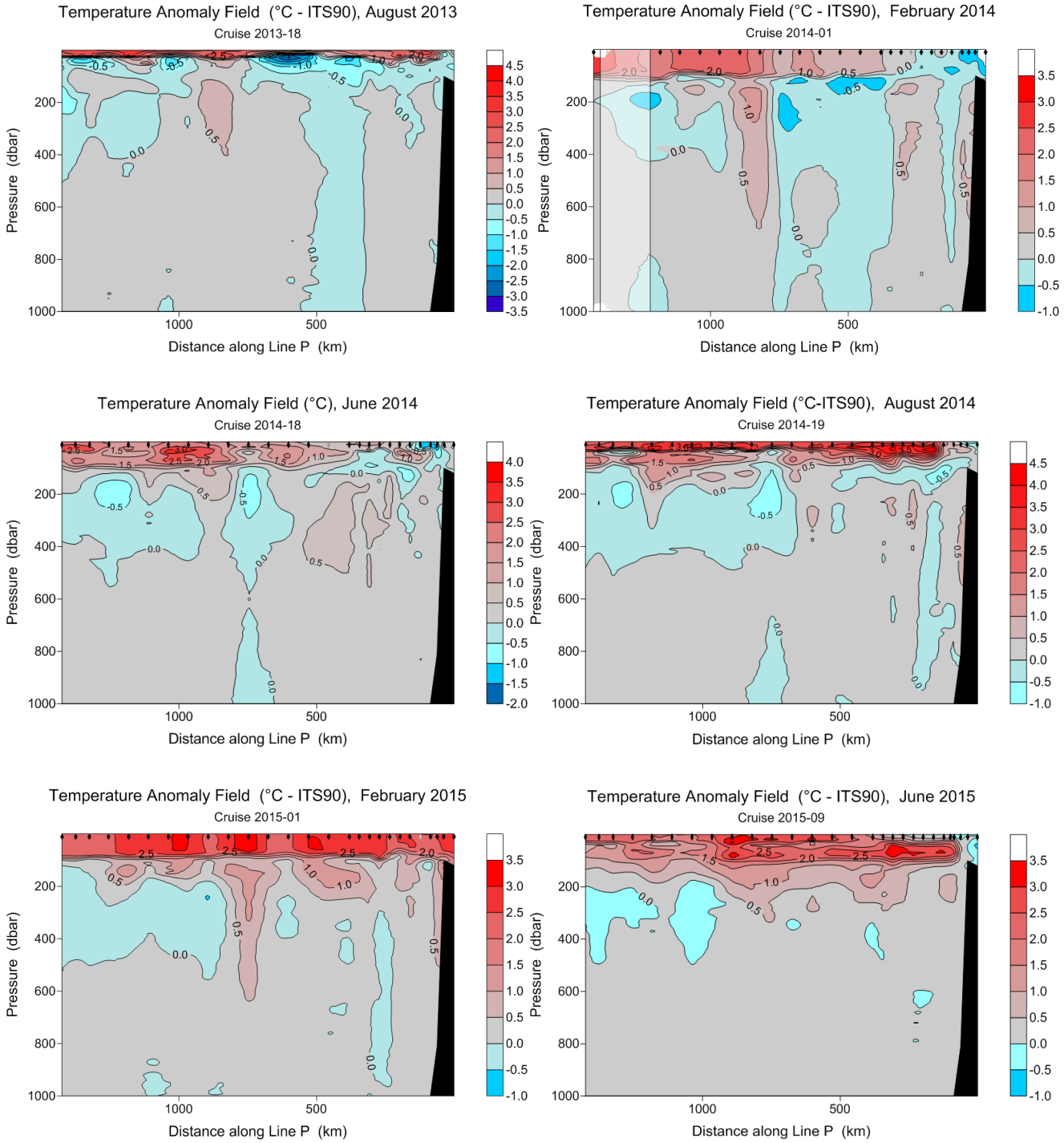


Figure 1: Temperature anomaly field with respect to the 1956 – 1991 averages for every Line P cruise since August 2013.

Jade Shiller UBC Line P – June 2015

Objectives:
Describe the taxonomic and metabolic diversity of the bacterial and viral communities in the cycling of major nutrients along Line P, focusing on the communities in the oxygen minimum zone.

Sampling summary:
At 5 stations (P4, P12, P16, P20, and P26)

1) 2 L seawater samples (at 16 depths) for high-resolution bacterial DNA sequencing were filtered.
2) 50 mL seawater samples were taken per depth to count the number of cells per milliliter using flow cytometry and single cell DNA analysis. Samples were aliquoted and preserved using glutaraldehyde and glycerol+TE, respectively.

Additionally, at 3 major stations (P4, P12, and P26), the following were sampled at four depths: 10, 500, 1000, and 2000 (bottom+10 at P4) across the oxygen minimum zone.

1) Large volumes (20 L) at each depth were filtered to create genomic libraries of the bacterial communities.
2) After adding of iron chloride to the filtered water, the samples were filtered again for later virus analysis.
3) For viral counts, samples were taken and preserved using glutaraldehyde and betaine.
4) 50 mL seawater samples were taken per depth to count the number of cells per milliliter using flow cytometry and single cell DNA analysis. Samples were aliquoted and preserved using glutaraldehyde and glycerol+TE, respectively.

Comments:

All my lab objectives for this cruise were successfully fulfilled. The work area distribution was very convenient for my sampling needs and I will try to use the same setup on future cruises.

I'd like to thank the captain and crew of the *Tully* for their assistance and excellent work throughout the cruise. Thanks to the IOS team and the scientists onboard for their help and their humour on deck and in the lab. And finally, a great big thank-you to Marie for patiently answering my numerous questions while I got my sea legs on my first Line P cruise.

Amanda Timmerman – University of Victoria

Biological productivity is an important process controlling the export of carbon to the deep ocean. There are multiple methods to estimate production and I focused on two techniques: dissolved gas ratios and incubations. Dissolved gas ratios included measurements of oxygen, nitrogen and argon (ONAr) ratios and triple oxygen isotope ratios. Incubations included 18O and dual 13C/15N additions.

ONAr: Samples were collected in duplicate at two depths within the mixed layer at P4, P12, P16, P20 and P26. ONAr samples collected on this cruise will be analyzed at the University of Victoria to obtain precise measurements of O2/Ar.

Dissolved oxygen: Duplicate samples were collected at 10 m, 100%, 50%, 30%, 15% and 1% light levels at P4, P12, P16, P20 and P26. Dissolved oxygen samples were analyzed on board using the Winkler titration method with a visual endpoint.

Triple oxygen isotope: Duplicate samples were collected within and below the mixed layer at P4, P12, P16, P20 and P26. The below the mixed layer depth was chosen based on the oxygen profile. Samples will be analyzed for the 16, 17 and 18 oxygen isotopes.

Dual tracer incubations, NH4, nutrients, chlorophyll: Samples were collected at 5 light depths (100, 55, 30, 10 and 1%) at P4, P12, P16, P20 and P26. Two sets of incubations were done using $NaH^{13}CO_3$ and either $^{15}NO_3$ or $^{15}NH_4$. $^{15}NO_3$ samples were done in duplicate at 100%, 15% and 1% light levels and singles samples at all other depths. $^{15}NH_4$ samples were collected in duplicate at 100% light level and all other depths had single replicates. A blank was collected at 100% light level for each ^{15}N nutrient. All incubations were incubated for 24 hours

under a constant flow of seawater and then filtered. Duplicate NH_4 samples and single nutrient and chlorophyll samples were collected at the 5 light depths as well.

Salinity: Samples were collected below the mixed layer, within the oxygen maximum and at 50%, 30%, 15% and 1% light levels at P4, P12, P16 and P26.

18O incubations: Triplicate samples were collected at 5 light depths (100, 55, 30, 10 and 1%) at P4, P12, P16, P20 and P26. Samples were spiked with 18O labeled water and incubated for 24 hours under a constant flow of seawater. After 24 hours, the samples were collected into flasks and will be analyzed at the University of Victoria.

Acknowledgements: Thank you to the Captain, officers and crew of the JP Tully for making the cruise productive. I also want to thank IOS personnel for their help sampling, filtering and analyzing samples. Many thanks to the science crew. Thank you especially to Marie Robert for her support and accommodating my sampling requests, Mariela White and Mark Belton for their help with sampling, Doug Yelland for his help with the PAR casts, and Glenn Cooper for his help with the incubators. I want to thank Sarah Thornton for allowing me to borrow equipment.

2015-09 Line P Cruise Report – Ben Twining[1] and Natalie Cohen[2]

[1]Bigelow Laboratory for Ocean Sciences, East Boothbay, Maine USA
[2]Laboratory of Adrian Marchetti, University of North Carolina at Chapel Hill, Chapel Hill NC, USA

Twining and Cohen conducted two incubation experiments to investigate the ecological function of iron storage within natural phytoplankton communities and determine differences in iron storage capacity between phylogenetically distinct groups. We aim to compare physiology and gene expression patterns in response to iron stress within natural communities by conducting incubation experiments designed to stimulate mechanisms for coping with iron-limitation and performing iron storage. One set of incubation experiments was performed at the coastal station P4 (48°39N, 126°40W) where iron is relatively abundant, and the other at P26 (50°00N, 145°00W) where iron is limiting to phytoplankton growth.

For each experiment, seawater was pumped from the depth corresponding to 33% PAR (typically 8-12 meters) via a trace metal clean seawater retrieval system consisting of Teflon-lined vinyl tubing and a Teflon diaphragm pump (provided by IOS). Incubations were conducted in 4-L polyethylene cubitainers. Triplicate cubitainers received either iron (5 nM) or an iron-chelator desferrioxamine (DFB; 200 nM). All cubitainers collected at P4 also received nitrate (10 µM). Unamended cubitainers served as a control. Containers were situated in two on-deck flow-through plexiglass incubators (provided by IOS) around sunrise with neutral density screening that allowed for 33% surface light to penetrate. Total incubation duration varied from 48 hours at P4 to 96 hours at P26. The following samples were collected from cubitainers in order to determine the response of the natural communities to iron treatments: POC, PON, N-15 uptake, C-13 uptake, Fv/Fm, flow cytometry, nutrients (to be analyzed by IOS), cell counts via light microscopy, biogenic silica, size fractionated chlorophyll, RNA, dissolved and particulate iron, and cellular iron quota measurements by X-ray fluorescence. Diatoms from incubations will be isolated and cultured at UNC. We expect to observe regulation of iron quotas, alternative iron pathways utilized to conserve iron, and/or iron uptake systems expressed consistent with previous findings (Moore, et al. 2002; Marchetti et al 2009; Strzepek and Harrison, 2004; Morrissey and Bowler 2012).

Acknowledgements
We thank the 2015-09 Line P scientists of IOS for their generosity and guidance, the officers and crew for their shipboard assistance, and the remaining members of the scientific party for their continued support. This work is supported by the National Science Foundation (NSF) under grant NSF OCE-1334632 to Adrian Marchetti and Ben Twining.

Carbonate Studies – Glenn Cooper, Marie Robert, Mike Arychuk; DFO-IOS

Four parameters of the carbonate system were measured on the 2015-09 mission. Both sea water pH and underway continuous automated pCO_2 were measured onboard the Tully. Samples for Total Inorganic Carbon (TIC) and Total Alkalinity (TA) were collected, preserved and returned to the Institute of Ocean Science (IOS) for further analysis.

1) Seawater pH analysis:

Seawater pH was determined using the spectrophotometric method developed by Clayton and Byrne (Deep Sea Research, 1993). Seawater was collected directly from the rosette Niskins into 10cm path length glass cuvettes. Meta-cresol purple (mCP) was used as the indicator dye and was validated prior to the cruise at IOS. The following stations were sampled: P01, P02, P04, P12, P16, P20, and P26. A set of triplicate samples were taken at P01 and P02 stations, whereas all other casts had two sets of triplicates which will be used to determine precision. A calibration cast was performed at P23. This consisted of collecting triplicates from 5 Niskins which were all closed at the same depth. Prior to the P01 cast, the water bath was not properly maintaining the set temperature. Luckily a backup water bath was brought on board. However, by the time that the old water bath was swapped out for the new water bath and everything stabilized to the analysis temperature, considerable time had elapsed since the samples were taken from the Niskins. Thus, the pH values for the P01 samples are considered suspect.

2) Total Inorganic Carbon and Alkalinity Sampling:

Total inorganic carbon and alkalinity (TIC/Alk) samples were collected at: P01, P02, P04, P12, P16, P20, and P26. One set of replicates was taken at each station. An entire extra set of samples was taken at P26 for archiving. A calibration cast was performed at P23. Samples were collected into 500 ml glass bottles and overfilled with one and a half volumes. Samples were poisoned with 100 µl of saturated mercuric chloride solution. Bottles were sealed with greased glass ground stoppers which are kept in place with electrical tape. Samples were stored at $4^{o}C$ until off loaded. We would like to thank all those who assisted us in the collections of these samples.

3) Tully Millipore MilliQ water system:

The chief engineer (Ryan Braidwood) raised concerns about the weight of mounting the MilliQ 30ℓ reservoir tank to the bulkhead of the ship. For this cruise the tank was placed on the bench, to the left of the sink in the main lab and secured to the wall. After discussions with Marie Robert it was decided that this location did not take up too much of the bench space and that we will continue to place it in this location. An alternative location could be under the life jacket rack by the right side of the sink. However this location is not as convenient to readily access Type 3 water and may also require some adaptation of the hosing to reach this area. If extra bench space was needed we could look at this as a possible alternative location for future cruises.

The relatively new MilliQ water maker performed exceptionally well and was problem free. For the entire cruise it was able to provided clean enough water for Mike Arychuk's extremely sensitive DMS analysis. The system was also able to keep up with the considerable demand for water on this particular cruise. The high demand may actually be a good thing, since water was not sitting around long enough in the tank to allow any possible growth of organisms. It is thought that this might be a likely source of a sulfur contaminant that Mike has occasionally detected on previous cruises.

Line-P report Crowe lab – Céline Michiels and Niko Finke; UBC.

Sampling on the rosette

N-species (NO_3^-, NO_2^-, NH_4^+) concentrations
N-cycle process rates measurements (^{15}N-labeled incubations):
    Denitrification, ANAMMOX, nitrification
Sulfide oxidation rates
CH_4 and N_2O concentrations
CH_4 production rates

Description of the Crowe lab sampling

N-cycle

We will generate profiles for the N-species (NO_3^-, NO_2^-, and NH_4^+) at P4, P12, P20 and P26. NO_3^- and NO_2^- will be measured by chemoluminescence and NH_4^+ (filtered samples) will be measured by fluorometry. We sampled for the N-cycle process rate measurements at P4, P12 and P26. Three depths from the Oxygen minimum zone (800m, 1000m and 1250m from P4, P12 and P26) were chosen to test for the presence of NO_3^- reduction and anaerobic ammonium oxidation via ^{15}N-labeled incubations. In addition to these depths, several depths were chosen throughout the water column to test for nitrification rates. Results for these ^{15}N-labeled incubations will be measured back at the lab on the IRMS.

Sulfide oxidation

We sampled 30 ml glass syringes (gas-tight) at the same OMZ depths as the ^{15}N-labeled incubations to test for potential sulfide oxidation at P4, P12 and P26. Sulfide oxidation rates were tested over a period of 12 hours with several additions of sulfide.

Gasses

We sampled for CH_4 and N_2O profile measurements at stations P3, P4, P8, P12, P16, P20, and P26. We sampled from the deep cast taking samples from most of the depth throughout the water column. Additionally, we took high resolution samples from the surface water from stations P4, P12, and P26. At these stations we also took water from the surface and the chlorophyll/fluorescence maximum depth to perform methane production incubations in the oxic water column. We incubated water from these depths in deck incubators and measured methane concentration time series in the gas headspace. Methane was measured on a GC equipped with and FID detector. Triplicate samples of various treatments (including control, dark, dark anoxic, filtered, Hg-killed) were measured.

Acknowledgements

We thank Marie for the help accommodating all our various needs to perform our work. We thank Mike for the help getting the gas bottles onto the ship as well as general organization and Mark for the help sampling. We also thank the entire white crew of the John P. Tully for the support making this work possible.

Measurements of atmospheric gases used for determining carbon export - Mariela White (U of W)

On this cruise (7-23 June 2015), a CTD package was successfully deployed on the PAPA mooring and the same recovered from last year's mooring. The CTD package includes an Aanderaa optode and Seabird 43 for oxygen measurement, a Paroscientific Gas Tension Device for measuring total gas pressure, a Wetlabs ECOFLNTUS for fluorescence and backscatter, and a Seabird 16plus for temperature and salinity. We took discrete water samples of oxygen and ONAr (Oxygen, Nitrogen, and Argon) at the sites of both the deployed and recovered moorings in order to calibrate these sensors. DIC and alkalinity were also collected in order to calibrate the MapCO2 system on the mooring for the NOAA carbon group. O^{18} samples were collected for Paul Quay of UW at station P in a profile down to 200m in order to determine biological productivity as part of an ongoing time series. Oxygen samples were run onboard using the winkler method on a dosimat provided by University of Victoria, and all other samples will be brought back to UW or NOAA for analysis.

The transport of carbon from the atmosphere into the ocean plays a significant role in controlling carbon dioxide content in the atmosphere. This flux is driven by biological production as well as physical absorption. We can measure the amount of biologically produced carbon exported to the deep ocean by making precise oxygen measurements and using the Redfield ratio. These oxygen measurements along with measurements of the biologically inert gases nitrogen and argon, allow distinction between physical processes that affect gas saturation from biological production and consumption of oxygen. The discrete measurements taken on this cruise, coupled with the high resolution data collected from the mooring allows us to estimate carbon export and work towards constraining the carbonate system at station P.

On behalf of Steven Emerson lab at the School of Oceanography UW, we would like to sincerely thank the officers and crew of CCGS John P Tully for all their hard work and invaluable assistance. Special thanks to chief scientist Marie Robert for being accommodating, arranging specific times for the calibration casts, and for being overall awesome to work with. Thank you IOS scientists for assisting with deployment/recovery day, overseeing rosette casts, and moral support. Thanks also to Amanda Timmerman of UVic for assisting with calibration cast sampling, and for scraping tape off our instruments. Line P cruises are always a great experience in collaboration and cooperation between the different ocean science institutions.

Thermosalinograph data – Marie Robert, DFO/IOS.

The TSG pond filter is not practical. The fluorescence signal kept increasing during the cruise as plankton grew in the filter. We tried to take the filter apart to clean it but it was too big of a task. The filter gets really heavy and the plankton is stuck to the foam. Also unless we take it all apart we don't know if it needs cleaning or not. We now suspect that the inside of the fluorometer casing itself might be covered in growth since, even after bypassing the filter, the fluorescence signal remained very high. We need to go back to a system where the growth inside the filter is visible and easily accessible.
Figure A below shows the TSG fluorescence signal along with the CTD fluorescence signal between the coast and Station P, whereas figure B shows both these signals during the three days spent in the vicinity of Station P.

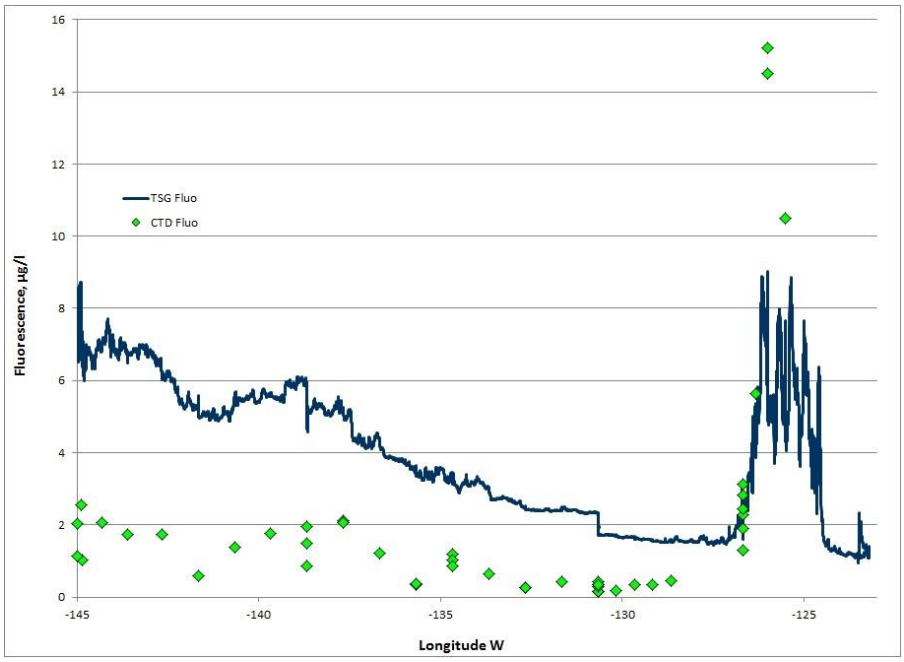


Figure A: Fluorescence from the Thermosalinograph and from the CTD along Line P, outbound leg.

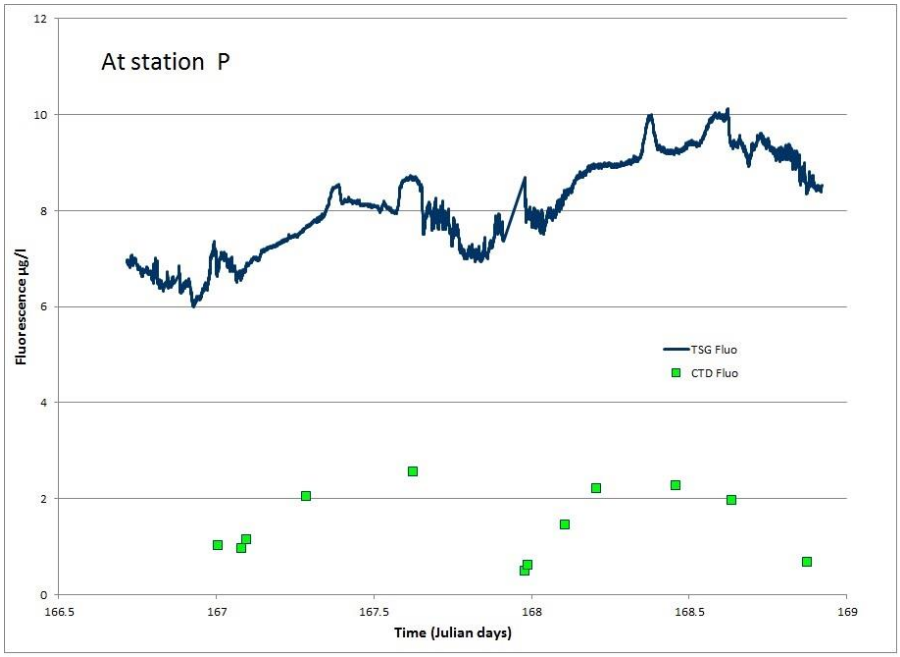
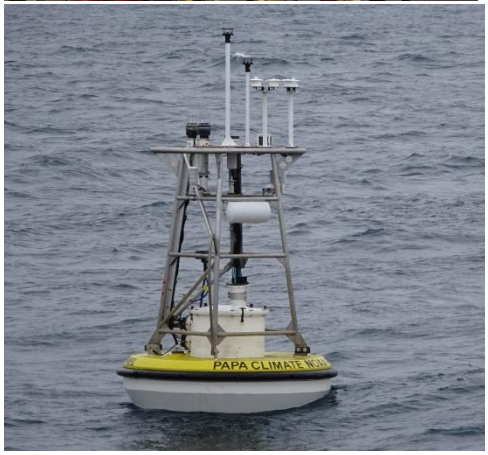


Figure B: Fluorescence from the Thermosalinograph and from the CTD at Station Papa.

NOAA Mooring Ops: - Jennifer Keene and Michael Craig.

DEPLOYMENT:

Deployment of the PA009 mooring then began at 19:30 UTC on Monday, June 15, 2015. The ship started from a position 4NM up wind of the desired anchor drop site. The buoy was deployed over the starboard side using a 16' strap, with one end of the strap in the release hook, and the other in the crane hook. A tagline to the crane hook helped to keep the hook clear of instruments on the tower once it was released. Subsurface instruments were pre-attached to the top 60m of nilspin flaked out on deck. This wire was passed over the rail by hand as the buoy paid out aft.

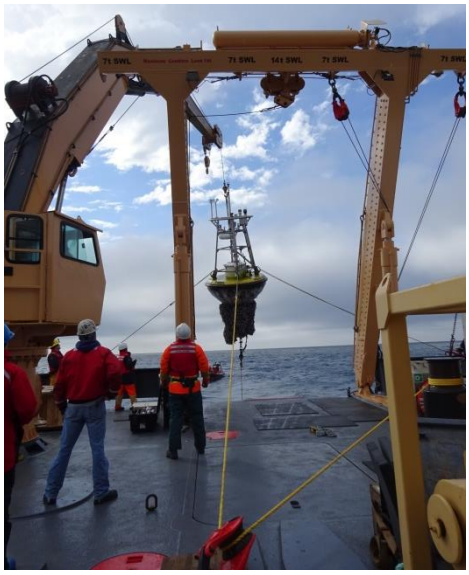


The rest of the deployment was then performed through a block on the A-frame. Remaining instruments were attached down to 300m, on the outboard side of the block. Once the wire was fully deployed, the nylon was allowed to payout freely as the ship steamed toward the anchor drop location. The mooring was towed for about an hour, and a Blake Slip was used to release the anchor off the stern at 23:18, for a total deployment time of 3:45. The anchor was dropped at 50° 07.836'N, 144° 50.372'W. After settling, the buoy reported its position to be 50° 7.5'N, 144° 49.9'W. At fly-by, all systems and sensors were returning data.

RECOVERY:

Comms with the acoustic release on PA008 were first attempted at 15:15 UTC on Tuesday, June 16, 2015. A clear response was not received, but it was believed to be released. The ship tracked the buoy location, and it was not clearly moving, so a second release attempt was made. A clear response was received and verified at 16:15 UTC.

The small boat was launched to attach a tow line and tag lines to the buoy, as the ship maneuvered to bring the buoy near the stern. The ship's capstan was used to pull the buoy in toward the stern, using a line attached to the side of the tower opposite the lifting handle. The crane hook was then lowered to the outboard side of the tower, where a strap on the lifting handle was attached. The crane lifted the buoy on board through the fully extended A-frame, steadied by a tag line on each side.



The buoy was brought on deck and temporarily secured just inside the A-frame, until it could be disconnected from the mooring, repositioned and secured. Once the buoy was onboard, the small boat was recovered. The buoy was then disconnected from the mooring, and secured out of the way on the starboard side of the aft deck.

The remainder of the mooring line was recovered through a block on the A-frame, similar to the deployment setup. Instruments were removed at the rail, while the line was powered in on the capstan and hand spooled onto reels. The release was brought on board at 22:05 UTC on June 16, 2015, for a total recovery time of about five hours, from the time the small boat was put in the water.

ACKNOWLEDGEMENTS:

The replacement NOAA mooring was safely deployed, and the existing mooring was successfully recovered. Project PI Meghan Cronin sends her sincere thanks to the captain and crew of the TULLY, and to IOS, for the continued partnership, hard work, and cooperation that make this ocean reference station mooring at Station P possible.

TULLY White Crew – CCG, “White does it right”
Marie Robert – IOS, Chief Scientist
Mariela White – UW, Technician, Assistance with mooring work & bridle sensors
Glenn Cooper – IOS, Assistance with mooring ops
Doug Yelland – IOS, Watch Leader, Support (and a lot of waiting)