#### ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CANADA

June 1st, 2015 to April 30th, 2016

#### **Accomplishments**

The main accomplishment this year was the successful completion of two cruises covering stations from the southern Labrador Sea to the western Beaufort Sea (see details in appendix 1). This was achieved despite a 2-week hiatus in our research program that resulted from the diversion of our ice breaker to open shipping lanes through the ice in eastern Hudson Bay.

Our situation garnered national and international attention, and was the subject of several news pieces on the CBC and Globe and Mail (eg. http://www.theglobeandmail.com/news/british-columbia/arctic-research-expedition-put-on-hold-after-vessel-diverted-to-break-ice/article25618672/).

Three of the GEOTRACES PIs wrote an Op-Ed on this topic: <u>http://www.theglobeandmail.com/globe-debate/canadas-ocean-science-capacity-is-limited-with-resource-constraints/article25729123/</u>.

#### Cruises

- GEOTRACES Arctic cruises: Labrador Sea, Baffin Bay and Canadian Arctic Archipelago; July 10-August 10, 2015 (Leg 2).
- GEOTRACES Arctic cruises: Beaufort Sea; September 4-October 1st, 2015 (Leg 3B).

*Cruise BLOG:* blogs.ubc.ca/geotraces2015

Radio interview: CBC Radio; "As it happens", July 22, 2015: *Ice Scientists* http://www.cbc.ca/radio/popup/audio/player.html?autoPlay=true&clipIds=2672371897,26723 29229

#### **Outreach** activities

We developed a highly successful program with the Vancouver Aquarium summer camps during 2015. PI Tortell worked closely with a number of UBC graduate students who spend several hours per week over the summer working with children (ages 8 - 14). Specifically, we designed a number of interactive, hands-on modules dealing with Ocean Acidification and Remote Sensing, with a particular focus on the Arctic. The modules included field-sampling at the beach next to the Aquarium, wet-chemistry work with pH buffers etc., computer-based analysis of ocean color imagery, and drone-based imaging of the Vancouver coastline. Our activities were highly successful, and plans are already under way to continue and expand this work for next summer. We also arranged for a live skype-call from the research vessel, with several scientists and Captain of the Amundsen spending about 30 minutes answering questions from children in the Aquarium gallery. The children and camp leaders seemed to be very excited by this opportunity.

## Individual activities

## Diana Varela; Biology Dept., University of Victoria, Victoria, BC

• Stable silicon isotope inter-calibration plans (UVic-Canada, UC Santa Barbara-USA, University of Brest-France): January - June, 2015

A series of discussions with collaborators in both the United States and France regarding intercalibration of the stable silicon isotope measurements on our respective Arctic Geotraces cruises. Samples with be collected at a crossover station for intercalibration with our US colleagues, while we will be collecting samples to share with our French colleagues as their crossover station (that they have already visited) was deemed unsuitable for intercalibration.

#### Refereed journal publications

• Crawford, David W.; Wyatt, Shea N.; Wrohan, Ian A.; et al.2015. Low particulate carbon to nitrogen ratios in marine surface waters of the Arctic. Global Biogeochemical Cycles 29 (12): 2021-2033

<u>Alfonso Mucci</u>; Department of Earth and Planetary Sciences, McGill University, Montreal, QC

#### Refereed journal publications

• Varela, D. E., M. A. Brzezinski, C. P. Beucher, J. L. Jones, K. E. Giesbrecht, B. Lansard, *and* A. Mucci (2016), Heavy silicon isotopic composition of silicic acid and biogenic silica in Arctic waters over the Beaufort shelf and the Canada Basin. Global Biogeochem. Cycles, 29, *doi*: 10.1002/2015GB005277.

#### **Presentations**

• The Canadian Arctic GEOTRACES Program : Biogeochemical and tracer study of a rapidly changing Arctic Ocean. Meeting of the NSERC-CCAR Networks, May 3, 2015

#### Media interviews

Opinion: Ocean acidification is an indisputable problem. The Gazette, June 22, 2015
<u>http://montrealgazette.com/news/world/opinion-ocean-acidification-is-an-indisputable-problem</u>

## Celine Gueguen; Chemistry Dept., Trent University, Peterborough, ON

• V. Mangal, C. Guéguen (2015) Examining concentrations and molecular weights of thiols in microorganism cultures and in Churchill River (Manitoba) using a fluorescent-labeling method coupled to asymmetrical flow field-flow fractionation. Anal Bioanal Chem (2015) 407:4305–4313

## Andrew Ross; Fisheries and Oceans Canada, IOS, Sydney, BC

I continue to assist in collecting samples for analysis of iron and other trace metals on the annual August/September Line-P cruises in support of our Line-P Iron Program (which is recognized as a Process Study by GEOTRACES).

I've also been supervising Kyle Simpson on his development of a new Fe analysis system here at DFO-IOS.

## Refereed journal publications

- Invited paper to the SCOR Working Group 139 Special Issue of the journal Frontiers in Marine Science (Marine Biogeochemistry section) on" Organic ligands A key control on trace metal biogeochemistry in the ocean":
- Richard L. Nixon (\*), Andrew R.S. Ross "Evaluation of immobilized metal-ion affinity chromatography and electrospray ionization mass spectrometry for the recovery and analysis of copper-binding ligands (chalcophores) in seawater" (in preparation, to submit by the May deadline)

## Kristin Orians; Earth, Ocean & Atmospheric Sciences, UBC, Vancouver

PhD student Nari Sim participated in the Particulate Metals intercalibration, lead by Phoebe Lam

#### <u>Refereed journal publications</u>

• McAlister, J. and Orians, K. (2015) Dissolved Ga in the Beaufort Sea of the Western Arctic Ocean: A GEOTRACES cruise in the International Polar Year. Marine Chemistry 177: 101-109

## Thesis

• McAlister, J. Biogeochemistry of dissolved gallium and lead isotopes in the northeast Pacific and western Arctic Oceans. Ph.D. Thesis, Oceanography, UBC (April 2015)

## Jay Cullen; Earth & Ocean Sciences, University of Victoria, Victoria, BC

#### *Refereed journal publications*

- Janssen, D.J. and J.T. Cullen. (2015) Decoupling of zinc and silicic acid in the subarctic northeast Pacific interior. Marine Chemistry 177: 124-133
- Schallenberg, C., A.B. Davidson, K.G. Simpson, L.A. Miller and J.T. Cullen. (2015) Iron(II) variability in the northeast subarctic Pacific Ocean. Marine Chemistry 177: 33-44
- Quay, P., J.T. Cullen, P. Morton and W. Landing. (in press). Processes controlling the distributions of Cd and PO4 in the ocean. Global Biogeochemical Cycles

Maite Maldonado; Earth, Ocean & Atmospheric Sciences, UBC, Vancouver, BC

- Participated in the Particulate Metals intercalibration, lead by Phoebe Lam (in collaboration with K. Orians)
- Full Member of SCOR Working Group 145: Modelling Chemical Speciation in Seawater to Meet 21st Century Needs (MARCHEMSPEC)
- Hosted the GEOTRACES Data Management (July 13-14) & Scientific Steering Committee (July 15-17) meetings in EOAS, UBC, Vancouver, BC.
- Organized and lead an international BioGeotraces meeting in Woods Hole Oceanographic (Fall 2015)

## Refereed journal publications

- Semeniuk, D.M., R.M. Bundy, A.M. Posacka, M. Robert, K.A. Barbeau, M.T. Maldonado. 2016. Using 67Cu to study the biogeochemical cycling of copper in the northeast subarctic Pacific Ocean. Frontiers in Marine Science (in press)
- Semeniuk, D.M., R.L. Taylor, R.M. Bundy, W.K. Johnson, J.T. Cullen, M. Robert, K.A. Barbeau, M.T. Maldonado. 2016. Iron-copper interactions in iron-limited phytoplankton in the northeast subarctic Pacific Ocean. Limnology and Oceanography 61, 279-297. doi: 10.1002/lno.1021
- Semeniuk, D.M., R.M. Bundy, C.D. Payne, K.A. Barbeau, M.T. Maldonado. 2015. Acquisition of organically complexed copper by marine phytoplankton and bacteria in the northeast subarctic Pacific Ocean. Marine Chemistry 173, 222-233. doi:10.1016/j.marchem.2015.01.005

Roger Francois; Earth, Ocean & Atmospheric Sciences, UBC, Vancouver, BC

## Refereed journal publications

- Brown, K. A, L. A. Miller, C. J. Mundy, T. Papakyriakou, R. Francois, M. Gosselin, G. Carnat, K. Swystun, P. D. Tortell. 2015. Inorganic carbon system dynamics in landfast sea ice during the early-melt period. J. Geophysical Res. Ocean 120 (5): 3542-3566
- Scheiderich, K, M. Amini, C. Holmden, and R. Francois. 2015. Global variability of Chromium isotopes in seawater demonstrated by Pacific, Atlantic, and Arctic Ocean samples. Earth and Planetary Science Letters 423: 87–97
- Jonkers. L, R. Zahn, A.Thomas, G. Henderson, W. Abouchami, R. Francois, P. Masque, I. R. Hall, and T. Bickert. (2015) Deep circulation changes in the central South Atlantic during the past 145 kyrs inferred from a combined sedimentary 231Pa/230Th, neodymium isotopes and benthic δ13C record. Earth and Planetary Science Letters 419, 14-21.
- Holmden, C., Amini, M. and Francois, R. (2015) Uranium isotope fractionation in Saanich Inlet: A modern analog study of a paleoredox tracer. Geochim. Cosmochim. Acta 153, 202-215.

## Bridget Bergquist; Department of Earth Sciences, University of Toronto

## <u>Refereed journal publications</u>

- Chandan, P.; Ghosh, S.; Bergquist, B.A. 2015. Mercury Isotope Fractionation during Aqueous Photoreduction of Monomethylmercury in the Presence of Dissolved Organic Matter. Environmental Science & Technology 49 (1): 259-267
- Rose, Carla H.; Ghosh, Sanghamitra; Blum, Joel D.; et al.2015. Effects of ultraviolet radiation on mercury isotope fractionation during photo-reduction for inorganic and organic mercury species. Chemical Geology 405: 102-111

## Chris Holmden; Department of Geological Sciences at the University of Saskatchewan

## Refereed journal publications

- Scheiderich, K. ; A. Marghaleray; C. Holmden, et al. 2015. Global variability of chromium isotopes in seawater demonstrated by Pacific, Atlantic, and Arctic Ocean samples . Earth and Planetary Science Letters 423: 87-97
- Holmden, C., Amini, M. and Francois, R. (2015) Uranium isotope fractionation in Saanich Inlet: A modern analog study of a paleoredox tracer. Geochim. Cosmochim. Acta 153, 202-215.

## Philippe Tortell; Earth, Ocean & Atmospheric Sciences, UBC, Vancouver, BC

## Refereed journal publications

- Capelle D.W., J.W.H. Dacey, and P.D. Tortell A high precision method for automated analysis of dissolved CH4 and N2O concentrations in natural waters. Submitted to Limonology and Oceanography Methods. ms# LOM-14-11-0112
- Asher E.C., J.W.H. Dacey, T. Jarnikova and P.D. Tortell. An automated ship-board method for sequential analysis of DMS, DMSP and DMSO in oceanic waters. Submitted to Limnology and Oceanography Methods 13 (9): 451-462

## **Presentations**

ArcticNet meeting, Vancouver BC., Dec. 8 - 11, 2015:

- PD Tortell et al. Summertime net community production, CO2 uptake and phytoplankton photo-physiology in Canadian Arctic and Subarctic ocean waters
- L Fenwick et al. Distribution of CH4 and N2O concentrations in the Canadian Arctic during summer, 2015
- T Jarnikova et al. Surface water concentrations of dimethylsulfide (DMS), dimethylsulfoniopropionate (DMSP) and dimethylsulfoxide (DMSO) in the Canadian Arctic Archipelago during summer, 2015

- N Schuback et al. Coupling of photosynthetic electron transport and carbon fixation in Arctic marine phytoplankton assemblages
- C Hoppe et al. Response of Arctic phytoplankton assemblages to experimental pco2 and light manipulations.

Susan Allen; Earth, Ocean & Atmospheric Sciences, UBC, Vancouver, BC

#### **Presentations**

ArcticNet meeting, Vancouver BC., Dec. 8 - 11, 2015:

- Sha, Y., S. Allen, X. Hu and P. Myers. A modeling study of dissolved Barium and  $\delta$ 180 in the Arctic. Student Poster Presentation. Dec 2015. Arctic sciences Network meeting
- Yu, X., S. Allen, X. Hu and P. Myers. Intermediate and deep water circulation changes in the Arctic (2002-2013): Inferred from the distribution of 231Pa/230Th in the water column. Student Poster Presentation. Dec 2015.

Jack Cornett; Department of Earth Sciences, University of Otawa

#### Refereed journal publications

- Sookdeo, A., Cornett, J., Kieser, W.E (2015) Optimizing production of Pb beams for 205,210Pb analysis by Accelerator Mass Spectrometry. Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms 361: 450–453
- MacDonald, C.M., Charles, C.R.J., Zhao, X.-L., Kieser, W.E., Cornett, R.J., Litherland, A.E. (2015). Determination of 135Cs by accelerator mass spectrometry. Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms. 361: 554-558.
- Charles, C.R.J., Cornett, R.J., Zhao, X.-L., Litherland, A.E., Kieser, W.E. (2015). On-line I-/Te separation for the AMS analysis of 125I. Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms. 361: 189-192.
- X.-L. Zhao, C. R. J. Charles, R.J. Cornett, W. E. Kieser, C. MacDonald, K. Zaki and N. St-Jean. (2015). An Exploratory Study of Recycled Sputtering and CsF2- current enhancement for AMS. Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms 366: 96–103
- MacDonald, C.M. R.J. Cornett, C.R.J. Charles, X.-L. Zhao, and W.E. Kieser. (2015). Measurement of the Cs-135 Half Life with Accelerator Mass Spectrometry and Inductively Coupled Plasma Mass Spectrometry. Physics Reviews C 93, 014310

#### Invited Presentations

• R.J. Cornett. (2015). Measuring Radionuclides using Mass Spectrometry. Health Canada Seminar Series, Ottawa, Canada. Nov, 2015

- R.J. Cornett. (2015). Mass Spectrometry Techniques and Applications in Geoscience. OCGC Student Seminar, Ottawa, Canada Sept 2015
- R. J Cornett, W.E. Kieser and X.L. Zhao. (2015). Nouvelles techniques isotopiques pour la géoscience. University of Aix- Marseille, Aix en Provence, France, June 2015
- R. J. Cornett and A. Sookdeo\* . (2015). MEASUREMENT OF PB-210. SpectrÀtom 2015, Halifax, Canada, June 2015
- R. J. Cornett, A. Sookdeo, and M. Khan . (2015). MEASUREMENT OF PB-210.BY MASS SPECTROSCOPY. SCL-CCFFR 2015, Ottawa, Canada, January, 2015
- R.J. Cornett. (2015). Applications of Accelerator Mass Spectrometry in Geoscience. ISWAN 2015, Ottawa, Canada February, 2015

## **Conference** Presentations

- M. Khan, R.J. Cornett and X.L. Zhao. (2015). Measuring Lead Isotopes by AMS. University of Ottawa Undergraduate Research Colloquium, Ottawa, Canada, March 2015
- D. Sauvé, and R. J. Cornett . (2015). ISOTOPE MEASUREMENT BY AMS IN THE LABRADOR AND BEAUFORT SEAS. . SCL-CCFFR 2015, Ottawa, Canada, January 2015

Paul Myers; Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta

#### <u>Refereed journal publications</u>

• Greenland Ice Sheet melt increases Baffin Bay heat content on the west Greenland shelf, 2015: L Castro de la Guardia, X Hu and PG Myers, Geophysical Research Letters, 42(12), 4922-4930

#### Invited conference presentation

• Freshwater Processes and Feedbacks in Baffin Bay and the Labrador Sea, May 2015, Paul G. Myers, Xianmin Hu, Amber Holdsworth, Laura Castro de la Guardia and Laura Gillard, Joint Canadian and American Geophysical Union Meeting, Montreal, QC.

#### Conference presentation

- Freshwater Processes in Baffin Bay and the Labrador Sea, March 2015, Laura Castro de la Guardia, Laura Gillard, Xianmin Hu and Paul G. Myers, Arctic SubArctic Ocean Fluxes Workshop, Bremerhavn, Germany
- Ocean Circulation and Marine Terminating Glaciers of the Greenland Ice Sheet and the Canadian Arctic Archipelago, June 2015, Laura C. Gillard, Xianmin Hu and Paul G. Myers, IUGG 2015, Prague, Czech Republic
- Positive Feedback between Baffin Bay Circulation and West Greenland Ice Sheet Melt, July 2015, Laura Castro de la Guardia, Xianmin Hu, Paul G. Myers, IUGG 2015, Prague, Czech Republic

- Numerical Modelling and Shelf-Basin Exchange in the Labrador Sea and Baffin Bay, November 2015, Paul G. Myers, Xianmin Hu, Clark Pennelly, Amber Holdsworth, Laura Gillard, Laura Castro de la Guardia, Ting On Chan and Juliana Marson, FAMOS Workshop, Woods Hole, Ma, USA
- Evolution of Baffin Bay water masses and transports in a climate change experiment including Greenland runoff, June 2015, Nathan Grivault, Xianmin Hu and Paul G. Myers, 49th CMOS Congress, June 2015, Whistler, B.C.
- Ocean Circulation and Marine Terminating Glaciers of the Greenland Ice Sheet and the Canadian Arctic Archipelago. Laura C. Gillard, Xianmin Hu, Paul G. Myers.CMOS Congress. May 31 – June 4, 2015

#### *Invited University Seminar* (Other – 1)

• Freshwater Processes and Feedbacks Between the Arctic and Sub-Polar North Atlantic Oceans, Paul Myers, CEOS, University of Manitoba, Winnipeg, Mb, February, 2015

#### *Presentation on Geotraces at NSERC Event* (other – 1)

 Canadian Arctic Geotraces Program, NSERC CCAR Research Day, May 2015, Montreal, Qc

Fei Wang; Department of Environment and Geography, University of Manitoba, Winnipeg, Manitoba

#### <u>Refereed journal publications</u>

• Wang F., Pucko M., and Stern G. 2015. Transport and transformation of contaminants in sea ice. In: Sea Ice, 3rd Ed. (Thomas D.N. Ed). Wiley-Blackwell. In press.

## Conference presentations (invited)

• Wang F. 2015. Cryospheric chemistry: Chemical processes in frozen waters. 98th Canadian Chemistry Conference and Exhibition, Ottawa, Canada. June 13-17, 2015.

#### *Conference presentations (not invited)*

• Wang K., Munson K. and Wang F. 2015. Mercury in the Marine Water of the Canadian Arctic. ArcticNet Annual Scientific Meeting. Vancouver, BC, Canada. December 7-11, 2015.

## (Social) Media

- Elliott A. Surprise visitors for the Canadian team. Blog at Researchgate.net. Posted on October 19, 2015.
- Xu W. Tough instruments on the CCGS Amundsen. Blog at Researchgate.net. Posted on September 22, 2015.

## **APPENDIX 1 - CANADA GEOTRACES**

#### **PROJECT REPORT:**

#### "A BIOGEOCHEMICAL AND TRACER STUDY OF A RAPIDLY CHANGING ARCTIC OCEAN"

## **<u>1. Research Project</u>**

#### Accomplishments

The main accomplishment during year 3 of our project has been the successful completion of two cruises covering stations from the southern Labrador Sea to the western Beaufort Sea. This was achieved despite a 2-week hiatus in our research program that resulted from the diversion of our ice breaker to open shipping lanes through the ice in eastern Hudson Bay. A cruise synopsis is given below.

#### 1.1 Cruise synopsis

Our 2015 field program consisted of 2 separate legs. The first leg (**Fig. 1**) covered the Labrador Sea, Baffin Bay and the eastern and central Canadian Arctic Archipelago (CAA). The second leg crossed Canada Basin and covered the western CAA (**Fig. 2**). Note that the first leg of the Arctic GEOTRACES cruise corresponds to Leg2 of the CCGS Amundsen summer expedition, while our second leg corresponds to Leg 3b for the Amundsen.

2015 CCGS Amundsen expedition LEG 2 GEOTRACES/ARCTICNET

July 10 – August 20, 2015

Quebec City – Kugluktuk

Chief Scientists: Roger Francois, Philippe Tortell

This leg was shared between the Canadian Arctic GEOTRACES project and ArcticNet. As part of the international GEOTRACES program, the principal mandate of our project was to study the input, removal and cycling of trace elements and isotopes in the water column, and to use this information to document, monitor, and predict the evolution of physical and biogeochemical processes in the Arctic Ocean. Our project was also complemented by very extensive biological and trace gas measurements, which not only meet the broader requirements of the CCAR program but also are of direct relevance to the long-term goals of ArcticNet, facilitating coordination of sampling between the two programs.

Sampling operations for GEOTRACES during this leg consisted of:

- seawater sampling with ArcticNet's 24 x 12 L rosette CTD (Niskin-type bottles)
- seawater sampling under trace metal clean conditions with a 12 x 12 L rosette CTD (Go-Flo bottles)
- particle sampling with 6 McLane large volume in-situ pumps
- aerosol sampling with a volumetric flow controlled high volume sampler
- underway trace gas analysis with a Membrane Inlet Mass Spectrometer (MIMS) and a Gas Chromatograph (GC)

Additional GEOTRACES activities included:

- incubations for productivity measurements with different isotopic tracers (<sup>13</sup>C, <sup>15</sup>N, <sup>32</sup>Si, <sup>18</sup>O, 2h <sup>14</sup>C and FRRF) complementing incubations conducted by ArcticNet (24h <sup>14</sup>C) and productivity estimates from water column measurements (O<sub>2</sub>/Ar, triple O isotopes, <sup>234</sup>Th deficit)
- Ship-board manipulation experiments to examine the impacts of ocean acidification and enhanced mixed layer stratification on phytoplankton productivity and physiological ecology.
- river sampling to assess continental input into the CAA (15 rivers draining into the Canadian Arctic Archipelago; **Fig. 1**)

## 2015 CCGS Amundsen Expedition LEG 3b GEOTRACES/ARCTICNET

September 4 – October 1, 2015

Sachs Harbour – Resolute

Chief Scientists: Roger Francois, Kristin Orians

The second leg was also shared between the Canadian Arctic GEOTRACES project and ArcticNet. As during our first leg, the main GEOTRACES sampling operations consisted of seawater sampling with ArcticNet's  $24 \times 12 L$  rosette – CTD, GEOTRACES' trace metal clean  $12 \times 12 L$  rosette – CTD, and particle sampling with 6 McLane large volume in-situ pumps. The biogeochemical study conducted during this leg was complemented by a 4-day process study during which mesoscale mixing was measured by conducting a Moving Vessel Profiler and CTD mesoscale and mixing survey in Wellington, Maury and Perry Channels (**Fig. 2**). The goal of this work was to assess the impact of physical processes on the supply of micronutrients to surface waters. Toward the same goal, a glider was deployed in Canada Basin during Leg 3a (August 21 - September 3), which preceded leg 3b. The glider data provided high resolution 2d observations of water column hydrography and micro-structure that will provide new insight into mixing and turbulence across the Arctic continental shelf.

## **1.2** Cruise Tracks and discrete sampling summary

#### 1.2.1 2015 CCGS Amundsen Expedition LEG 2

The initial plan for Leg 2 was to occupy 15 stations (2 stations in the Labrador Sea, 4 in Baffin Bay, and 9 in the Canadian Arctic Archipelago). Additional stations were to be occupied for ArcticNet on a section between Greenland and Devon Island, and in Kane Basin, Kennedy Channel and Petermann Fjord. Time was also allocated for additional stations in Queen Maud Gulf as part of The W. Garfield Weston Foundation - Parks Canada - ArcticNet collaborative project.

The work in the Labrador Sea was completed on schedule, but on July 19<sup>th</sup> the ship was unexpectedly diverted to Hudson Bay for ice-breaking duties. The resulting 2-week hiatus (from July 19<sup>th</sup> to August 3<sup>rd</sup>) demanded a dramatic re-organization of the cruise plan. To the benefit of the GEOTRACES program, ArcticNet cancelled nearly all its stations and the remaining science plan was reduced to occupying 3 of the 4 GEOTRACES Baffin Bay stations and 7 of the 9 archipelago (CAA) stations (Fig. 1). GEOTRACES sampling strategy

in the CAA was also adjusted to existing ice conditions and to optimize scientific return within the remaining time. By the end of leg 2, GEOTRACES only lost 3 of its 15 stations (one station in eastern Baffin Bay and 2 stations in the CAA). The latter two of this skipped stations were sampled during the following leg 3B, so that our program only lost one station, which was deemed less important for the program (the CAA through flow into Baffin Bay, which was our main target, occupies the eastern side of the bay). Overall, the change in ship-operations had a large negative impact on proposed ArcticNet work, but almost no detrimental effect on the GEOTRACES program. We are extremely grateful to our collaborators at ArcticNet who went out of their way to ensure that our field campaign was successful. The scheduling and logistical issues we encountered highlight the larger problems associated with oceanographic ship-time allocations in Canada. Our situation garnered national and international attention, and was the subject of several news pieces on the CBC and Globe and Mail. Three of the GEOTRACES PIs wrote an Op-Ed on this topic:

http://www.theglobeandmail.com/globe-debate/canadas-ocean-science-capacity-is-limited-with-resource-constraints/article25729123/.

By the end of leg 2, the GEOTRACES project completed:

- 67 hydrocasts with ArcticNet's CTD-rosette
- 31 hydrocasts with GEOTRACES' trace metal clean CTD- rosette
- 24 casts with GEOTRACES' six large volume pumps
- 22 deployments of XCTDs
- 1 GEOTRACES trace metal clean deck pump deployment (to sample clean water for large volume incubation experiments).

This resulted in 1,545 seawater or marine particle samples for multi-element and isotopic analysis (Table 1), which will amount to >6,000 individual measurements.

We also conducted 278 incubations for carbon fixation and nutrient uptake measurements (88 two-hour <sup>14</sup>C incubations/FRRF, 60 <sup>13</sup>C and <sup>15</sup>N incubations, 60 <sup>32</sup>Si incubations, 60 <sup>18</sup>O incubations, 10 <sup>55</sup>Fe incubations), which were complemented by ArcticNet's 156 twelve-hour <sup>14</sup>C incubations.

Two  $CO_2$  / light manipulation experiments and sampling at 15 Arctic rivers draining in the CAA (**Fig. 1**) were also successfully completed.

## 1.2.2 2015 CCGS Amundsen Expedition LEG 3b

The CCGS *Amundsen* left Sachs Harbour on September 4<sup>th</sup> for our first station (CB1) in McClure Strait (Fig. 2) before crossing Canada Basin to occupy our next three stations (CB2 - CB4). The latter station was the location chosen for a cross-over station for inter-calibration with the US Arctic GEOTRACES program. Two stations were occupied in the archipelago (CAA8 and CAA9) to make up for the two stations lost during Leg 2.

During leg 3b, the GEOTRACES project completed:

- 22 hydrocasts with ArcticNet's CTD-rosette
- 21 hydrocasts with GEOTRACES' trace metal clean CTD- rosette
- 12 casts with GEOTRACES' six large volume pumps

This resulted in 709 seawater or marine particle samples for multi-element and isotopic analysis.

## 1.3 Parameters measured or sampled in the water column

## 1.3.1 2015 CCGS Amundsen Expedition LEG 2

Seventy-six chemical and biological parameters (Table 1) were measured on board or sampled for later analysis for vertical water profiles

In addition, several parameters were continuously measured or sampled along the cruise track:

- Atmospheric Hg concentration (Gaseous Elementary Mercury [GEM], Reactive Gaseous Mercury [RGM] and Particulate Hg [PHg]) with an automated Tekran atmospheric mercury speciation system. Discrete GEM measurements were obtained every 5 minutes. Analysis of PHg and RGM samples occurred after 2-hour collection periods.
- Surface gas measurements were conducted using automated purge and trap gas chromatography (PT-GC; for DMS/P/O), and membrane inlet mass spectrometry (MIMS; for CO2, DO2/Ar, and DMS) from the ship's seawater intake (**Figs. 3 and 4**).
- Photo-physiological measurements (e.g. variable Chla fluorescence, Fv/Fm, and cross sectional absorption area, s) were measured from the ship's seawater intake using an FRRF equipped with a flow-through measurement cuvette (**Fig. 5**).

Using the MIMS  $DO_2/Ar$  data, and a steady-state mixed layer  $O_2$  model, we were able to derive quantitative estimates of Net Community Production along the cruise track (**Fig. 6**).

## 1.3.2 2015 CCGS Amundsen ExpeditionLEG 3b

Fifty-seven chemical and biological parameters (Table 2) were measured on board or sampled for later analysis for vertical water profiles

## 1.4 Cruise participants

The GEOTRACES group on board the CCGS Amundsen during LEG 2consisted of:

- 4 Principal Investigators (Francois, Tortell, Cullen, Thomas)
- 2 Research Technicians
- 4 Postdoctoral Fellows
- 9 PhD students
- 3 MSc students
- 1 BSc student

from 7 Canadian universities (University of Victoria, University of British Columbia, University of Manitoba, Trent University, University of Toronto, McGill University, Dalhousie University) and 2 partner foreign institutions (Alfred Wegener Institute, Woods Hole Oceanographic Institution)

The GEOTRACES group on board the CCGS Amundsen during LEG 3b consisted of:

- 3 Principal Investigators (Francois, Orians, Klymak)
- 3 Research Technicians
- 9 PhD students

- 3 MSc students
- 1 BSc student

from 8 Canadian universities (University of Victoria, University of British Columbia, University Saskatchewan, University of Manitoba, University of Toronto, University of Ottawa, McGill University, Dalhousie University)

#### Anticipated research direction for the remaining of the award

Some analyses were performed on board (e.g. underway trace gases, <sup>14</sup>C primary productivity measurements, FRRF, incubation experiments) and these data are now being processed for interpretation and publication (e.g. **Fig. 3** – **6**). Indeed, a number of PIs and students have already prepared GEOTRACES-based presentations for the upcoming ArcticNet meeting in Vancouver. Other measurements, particularly the core parameters of the international GEOTRACES program, require extensive sample processing in laboratories, which will be completed during year 4.

We have organized a first PI meeting in Vancouver on December 7, which coincides with the annual ArcticNet meeting. The purpose of this meeting is to take stock of the data and samples in hand, coordinate analysis, and start discussing publication of results (see agenda in the appendix). We have already made plans to set up a linked computer server to more freely exchange core and ancillary data among the different research groups.

Coordination will carry on during year 4 at several levels:

- Collaborations within the PIs of the Canadian GEOTRACES program
- Collaborations at the national level with the Network of Centres of Excellence ArcticNet, with the CCAR project VITALS, and with JOIS and C3O programs of the Department of Fisheries and Ocean.
- Collaborations at the international level with our US, German and French partners to produce a quasi-synoptic database over most of the Arctic Ocean

## 2. Growth of the research team and management structure

With the successful conclusion of two major oceanographic cruises, our group has become tightly consolidated. Almost all of the PIs had at least one representative at sea, and the field work provided an ideal opportunity to further enhance our collaborative relationships. Indeed, we were extremely happy with the positive working atmosphere maintained on the ship, and the extent to which all group members (from senior PIs to B.Sc. students) worked collectively as a unified team. PIs Tortell, Cullen, Orians and Francois worked closely (in conjunction with PDF Kristina Brown and Technician Maureen Soon) to oversee the field operations. In a number of instances (e.g. during our two week sampling hiatus in Hudson Bay), this group needed to make 'executive decisions' regarding sampling priorities. The success of our field program is a testament to the ability of our group leaders to manage the broader research group and achieve consensus on critical issues (often under difficult conditions).

There has also been a further deepening of our partnership with DFO collaborators, and with the Vancouver Aquarium. We had significant representation from DFO scientists in our GEOTRACES Amundsen cruises, and we also participated in two additional DFO-led sampling programs on the CCGS Wilfrid Laurier and CCGS Louis St. Laurent. The joint GEOTRACES-DFO research will ensure that our results are efficiently translated into DFO- led modelling activities in support of enhanced monitoring and ecosystem management. We worked closely with the staff at the Vancouver Aquarium in the development of summer camp programs. DFO managers and representatives from the Aquarium will attend our project meeting in December.

## **<u>3. HQP training</u>**

As indicated above, 26 students (19 PhD, 6 MSc, 2 BSc), 2 postdocs, and 5 research staff were responsible for most of the analysis and sampling during the 2015 field season. Additional HQP were also involved in the project, but did not need to participate to field work (e.g. modelers) or could not be accommodated because of berth limitation.

The total number of HQP involved in the project to date is:

57 students (16 BSc, 17 MSc, 24 PhD), 6 postdocs, and 13 research assistants, for a total of 76 HQPs

Students and postdocs have been involved in all important aspects of the research, including the development of research questions and methodologies, data collection and interpretation. They will also play a leading role in the presentation and publication of the results.

# 4. Collaboration and interaction with federal government researchers and foreign partners

International collaboration is at the core of the GEOTRACES program, and the 2015 Arctic GEOTRACES program is built on the coordination of field work between 3 nations (US, Germany, Canada) to produce a quasi-synoptic database over the entire Arctic Ocean (**Fig. 7**). The overall Canadian transect links the North Atlantic, which was visited in 2014 by the French GEOVIDE program, to the US transect, which entered the Arctic from the North Pacific to cross over the German cruise track at the North Pole. The Canadian contribution will also document the transformation of Pacific waters along their transit through the CAA towards the North Atlantic.

One key aspect of the international GEOTRACES program is inter-calibration of analyses conducted on each individual section. The Canadian Arctic section is being inter-calibrated with the French GEOVIDE section which covered the North Atlantic in 2014, and with the US Arctic GEOTRACES section. For inter-calibration with the French transect, Canadian PIs have collected duplicate samples that will be analyzed by those who conducted similar analysis on the French cruise. For inter-calibration with the US, the plan was to occupy the same station in Canada Basin (Canadian station CB4 or US Station GTC56) at approximately the same time. Bad weather prevented the US group from deploying their trace metal clean rosette when they occupied this station, approximately one week after our own occupation. Therefore, while we will be able to conduct our inter-calibration as planned for the parameters collected with the regular rosette, we will rely on another accepted inter-calibration method for trace metals and isotopes. We have collected duplicate samples at CB4, which we will send to our US colleagues, who have, likewise, collected duplicate samples for us at a nearby station (GTC57; Fig. 7). In addition, since they have sampled trace elements and isotopes profiles at two stations that bracket our CB4 station, we will also compare these results using the Carina routine (Lauvset, S. K. and Tanhua, T. (2015), A toolbox for secondary quality control on ocean chemistry and hydrographic data. Limnology and Oceanography: Methods. doi: 10.1002/lom3.10050). We have confirmed that this approach will satisfy GEOTRACES' Standards and Inter-calibration Committee.

Collaboration with DFO partners has been strengthened by the participation of DFO scientists (Ross, Smith, Miller, Williams, Vagles) in the interpretation of the data and/or measurements of the samples collected in our Amundsen Cruises, and by our participation on DFO-led cruises on the CCGS *Laurier* and *Louis St Laurent*. For example, in collaboration with Svein Vagle and Bill William (IOS), we collected hundreds of additional samples for N<sub>2</sub>O and CH<sub>4</sub> analysis in the Bering / Chuchki Sea and Canada Basin. These additional samples provide nearly unprecedented coverage of N<sub>2</sub>O and CH<sub>4</sub> analysis across a wide swath of the Arctic Ocean continental shelf. They also provide significant 'value-added' measurements to the background DFO-led monitoring programs. An example of our recently obtained results is shown in **Fig. 8**. We have also continued to collaborate with DFO/EC modeller Nadja Steiner, who is working on a new marine Arctic ecosystem model. The results of CO<sub>2</sub> / light incubation experiments will help guide parameterizations of phytoplankton responses to climate perturbations.

## 5. Data management

Ultimately, our data will be integrated into the international GEOTRACES database. The GEOTRACES International Data Assembly Centre (GDAC) is hosted by the British Oceanographic Data Centre, located in Liverpool, and is jointly funded by the Scientific Committee on Oceanic Research, US National Science Foundation and the UK Natural Environment Research Council. The GDAC compiles data received from core international GEOTRACES cruises, and works closely with the GEOTRACES steering committee and scientists to establish common metadata and format protocols. The metadata for the two Canadian GEOTRACES cruises have already been sent to GDAC. We will send our data following completion of our analysis to the GEOTRACES' Standard and Intercalibration Committee for evaluation before their integration in the database. By the beginning of next year, we will also set up a suitable electronic platform for sharing raw and processed data between PIs to facilitate interaction and synergy between the sub-projects.

## 6. Communication, promotion and publication of research results

## Publications:

It is expected that publications from the Canadian Arctic GEOTRACES project will reach a peak during year 4 and 5 of the project. In the meantime, publication of preliminary results and methods development continue apace. During year 3, the group has published 19 peer-reviewed papers and 37 conference abstracts related to method development associated with our work.

Outreach:

We developed a highly successful program with the Vancouver Aquarium summer camps. PI Tortell worked closely with a number of UBC graduate students who spend several hours per week over the summer working with children (ages 8 - 14). Specifically, we designed a number of interactive, hands-on modules dealing with Ocean Acidification and Remote Sensing, with a particular focus on the Arctic. The modules included field-sampling at the beach next to the Aquarium, wet-chemistry work with pH buffers etc., computer-based analysis of ocean color imagery, and drone-based imaging of the Vancouver coastline. Our

activities were highly successful, and plans are already under way to continue and expand this work for next summer. We also arranged for a live skype-call from the research vessel, with several scientists and Captain of the Amundsen spending about 30 minutes answering questions from children in the Aquarium gallery. The children and camp leaders seemed to be very excited by this opportunity.

## 7. Reply to reviewers' comments from the previous year's report

Two of the reviewers were fully satisfied with the progress made in year 2. A third reviewer had a few comments and questions (reproduced in *italics*) that are addressed below.

"As a GEOTRACES program the issue of an intercalibration station is important. According to the planning this station coincides with the GEOVIDE station in the Labrador Sea sampled in 2014. However that station has been moved to a location which is part of the VITALS section. What will be the implications, since intercalibration will now exclusively concern analytical methodologies and not the sampling from different platforms, and by different operators?"

To address the issue of inter-calibration in the absence of a specific cross-over station, we followed the protocols outlined by the International GEOTRACES Program Office:

# Inter-calibration Procedures required for GEOTRACES Cruises without Crossover Stations and recommended for cruises with crossover stations.

1. Cruises without a crossover station are required to sample at least 3 depths in replicate at 2 different stations, at least for all key parameters, and samples from these inter-calibration depths must be distributed to at least one other laboratory for TEI determinations. Replicate sampling is recommended for other parameters as well.

2. The primary analysts for each TEI(s) should arrange for other independent laboratories to conduct the analyses of replicate samples.

3. Examine replicate data taking into account (i) Certified Reference Materials(CRM's) data for the two labs involved (e.g. SAFe and /or GEOTRACES, GoShip protocols for nutrient CRMs) and (ii) the use of isotope double spikes where appropriate.

4. Produce a report on the inter-calibration process stating what the level of agreement is between data, and whether any changes (e.g., recalibration) were required to one or both datasets/methods to bring data into agreement. In this report, please provide all metadata, which should include sample handling details, overall precision and accuracy of results, details about calibration and blanking, and subsequent data processing. Recoveries of CRM's or consensus reference materials (e.g.,SAFe and /or GEOTRACES) appropriate for selected TEIs should also be reported.

## "Primary productivity:

It is not Clear whether 15N enrichment experiments will also be conducted for NH4+ uptake (in dual labelling mode with 13C). It is important that this be done at all selected PAR depths. If possible, some 15N-N02 uptake experiments would be useful as well."

Incubations with  ${}^{15}NH_4^+$  were conducted at selected PAR depths at all stations during leg 2.  ${}^{15}N-NO_2^-$  uptake experiments were not part of planned activities (due to time/berth constraints).

"Measurement of NH4+ and also N02- profiles seem crucial to me. In the report (Productivity Group notes, page 5) it seems uncertain that these will be measured on board  $(NO_2^{-1} is not mentioned at all)$ ."

 $NH_4^+$  and  $NO_2^-$  concentrations were measured at all of the main hydrographic stations during leg 2.  $NH_4^+$  was not measured on leg 3b, which had a much smaller biological component.

"It is mentioned that 234Th analyses (L. Miller) will be integrated in the results of the productivity group. The report does not detail much about the planned approach to achieve this. Will this be done at all PP stations?"

During Leg 2, samples for <sup>234</sup>Th measurements (total, suspended particles, and sinking particles collected with a large volume pump) were collected at the 13 stations were primary productivity was measured. No <sup>234</sup>Th or productivity measurements were planned for leg 3b, due to logistical constraints and lack of biological context.

"Trace metals: The group note on particulate trace metals mentions that sampling will be done from Go-Flo bottles and clean rosette, and I understand that matching of these data with POC will depend on sampling with LVP's. Would it be possible to fit some LVP's with QMA filters (acid pre-cleaned.) which would allow for at least some TM's a direct comparison with POC."

Particulate trace metals were obtained by filtering 12L of seawater collected with the TM rosette at the same depths as for dissolved metals, which also coincided to the depths POC and particulate Si were collected using the regular rosette. LVPs were used to collect particles for <sup>230</sup>Th, <sup>231</sup>Pa, Nd isotopes, Cr isotopes, Si isotopes, and elements not prone to contamination.

"In any case LVP's will need to be used to assess 234Th/POC ratios to calculate export production".

A LVP was deployed at the base of the euphotic zone at each station to collect sizefractionated particles for Th-234 and POC analysis

"Most TM's are measured in the particulate and the dissolved phase. This seems not to be the case for Ba. It would be useful to analyse also dissolved Ba"

Samples for dissolved Ba analysis were collected at all stations during Leg 2 and Leg 3b.

# **Tables and Figures**



**Figure 1.** GEOTRACES station locations on the first sampling section (2015 CCGS *Amundsen* Expedition Leg 2)



**Figure 2.** GEOTRACES station locations on the second sampling section (2015 CCGS *Amundsen* ExpeditionLeg 3b). The glider survey was conducted during 2015 CCGS *Amundsen* Expedition Leg 3a (August 21 – September 3).



**Figure 3.** Underway measurements of surface water hydrography (temperature and salinity), phytoplantkon biomass (inferred from Chlorophyll a levels) and bio-active gases ( $\Delta O_2/Ar$ , pCO<sub>2</sub> and DMS). Gases were measured using ship-board membrane inlet mass spectrometry.



**Figure 4.** Underway hydrgrography and surface water gases (as in Fig. 3), but showing the spatial distribution along the cruise track. Note the areas of high apparent biological productivity indicated by elevated  $\Delta O_2/Ar$  and low surface water pCO<sub>2</sub>.



**Figure 5.** Continuous underway measurements of phytoplankton photo-physiological properties measured using Fast Repetition Rate Fluorometry (FRRF). Bottom panel shows the daily cycles in photosynthetically active radation (PAR), while upper panels show derived values of photosynthetic efficiency (Fv/Fm), cross-sectional area of photosystem-II ( $\sigma$ ), time constant for reoxidation of primary electron acceptor Qa ( $\tau$ ) and the maximum and light-dependent slope of photosynthetic electron transport in short-term P vs. I curves (Pmax and  $\alpha$ , respectively).



**Figure 6.** Derived Net Community Production (NCP = photosynthesis minus mixed layer respiration) obtained from MIMS  $\Delta O_2/Ar$  data and wind-speed dependent gas exchange parameterization. The calculations were conducted following the steady-state mixed layer mass balance model (Reuer et al. 2007) that has been used in a number of previous studies.



**Figure 7:** German (top), Canadian (middle) and US (bottom) GEOTRACES stations occupied between July and October 2015.



**Figure 8:** Depth profiles of CH<sub>4</sub> concentrations collected on the CCGS Laurier during July, 2015 (chief scientist S. Vagle, IOS-DFO). These measurements were supported by a collaboration with DFO that enabled us to greatly expand our sampling activities and provide significant 'value-added' information to on-going DFO time-series work.

Hydrography/CTD sensors	Trace gases				
Pressure	Biogenic gases				
Temperature	CH4, N2O				
Salinity	O2/Ar, N2/Ar (K1; LS2; BB1, 2, 3; CAA1, 3, 4, 5, 6, 7)				
Oxygen	Triple oxygen isotopes (K1; LS2; BB1, 2, 3; CAA1, 3, 4, 5, 6, 7)				
Fluorescence	Noble gases (K1 and BB2)				
Light transmission	Trace elements and isotopes				
Nutrients	Dissolved and particulate trace metals				
Phosphate	Al, Mn, Fe, Cd, Zn, Cu, Pb, Ga, Ba, REE, Hg, MeHg				
Nitrate/Nitrite	Dissolved and particulate radioisotopes				
Ammonia	<sup>230</sup> Th, <sup>231</sup> Pa, <sup>234</sup> Th, <sup>228</sup> Ra, <sup>224</sup> Ra, <sup>223</sup> Ra				
Silicate	Dissolved and particulate radiogenic isotopes				
Chemical parameters	Nd, Pb				
Dissolved inorganic carbon	Dissolved and particulate stable isotopes				
Total alkalinity	$\delta^{18}$ O in water				
На	δ <sup>13C</sup> in DIC				
Dissolved organic carbon	$\delta^{15}$ N and $\delta^{18}$ O in nitrate				
Fluorescent dissolved organic matter	δ <sup>30</sup> Si				
Coloured dissolved organic matter	δ <sup>53</sup> Cr				
Thiols	$\delta^{56}$ Fe				
Organic ligands	Anthropogenic isotopes				
Biological parameters	<sup>129</sup> I, <sup>236</sup> U, <sup>135</sup> Cs				
Particulate organic carbon	Large volume in-situ pumps				
Particulate organic nitrogen	Paticulate <sup>230</sup> Th, <sup>231</sup> Pa, <sup>234</sup> Th				
Size fractionated chlorophyll a	Paticulate Si, Nd and Cr isotopes				
Pigments					
Particulate biogenic silica					
Flow cytometry					
Genomics					
Proteomics					
Incubations					
<sup>14</sup> C uptake (K1; LS2; BB1, 2, 3; CAA1, 2, 3, 4, 5, 6, 7; VS)					
<sup>13</sup> C uptake (K1; LS2; BB1, 2, 3; CAA1, 3, 5, 6, 7)					
<sup>15</sup> NO3 uptake (K1; LS2; BB1, 2, 3; CAA1, 3, 5, 6, 7)					
<sup>15</sup> NH4 uptake (LS2; BB1, 2, 3; CAA1, 3, 5, 6, 7)					
<sup>32</sup> Si uptake (LS2; BB1, 2, 3; CAA1, 3, 5, 6, 7)					
H <sub>2</sub> <sup>18</sup> O uptake (K1; LS2; BB1, 2, 3; CAA1, 3, 5, 6, 7)					
<sup>55</sup> Fe uptake (CAA3, 7)					

Table 1: List of parameters measured or sampled in the water column

Hydrography/CTD sensors		Trace elements and isotopes					
Pressure		Dissolved and particulate trace metals					
Temperature		Al, Mn, Fe, Cd, Zn, Cu, Pb, Ga, Ba, REE, Hg, N					MeHg
Salinity		Dissolved and particulate radioisotopes					
Oxygen		<sup>230</sup> Th, <sup>231</sup> Pa, <sup>234</sup> Th, <sup>228</sup> Ra, <sup>224</sup> Ra, <sup>223</sup> Ra					
Fluorescence		Dissolved and particulate radiogenic isotopes					
Light transmission		Nd, Pb					
Nutrients		Dis	Dissolved and particulate stable isotopes				
Phosphate			$\delta^{18}$ O in water				
Nitrate/Nitrite			$\delta^{_{13C}}$ in DIC				
Silicate			$\delta^{15}$ N - nitrate				
Chemical parameters			δ <sup>30</sup> Si				
Dissolved inorganic carb	on		δ⁵³Cr				
Total alkalinity			$\delta^{56}$ Fe				
рН		Ant	Anthropogenic isotopes				
Dissolved organic carbor	1	<sup>129</sup> I, <sup>236</sup> U, <sup>135</sup> Cs					
Fluorescent dissolved organic matter		Large volume in-situ pumps					
Coloured dissolved orga	nic matter	Paticulate <sup>230</sup> Th, <sup>231</sup> Pa					
Thiols		Paticulate Si, Nd and Cr isotopes					
Organic ligands							
Biological parameters							
Particulate organic carbo	n						
Particulate organic nitro	gen						
Pigments							
Particulate biogenic silica							
Genomics							
Proteomics							

Table 2: List of parameters measured or sampled in the water column

## **Canadian Arctic-GEOTRACES Project Meeting**

Dec. 7th, 2015, 4pm - 6:30pm (Oak Room, Westin Bayshore, Vancouver)

#### <u>Agenda</u>

- 1. Overview of this summer's Canadian Arctic-GEOTRACES field sampling activities (*Roger Francois*)
- 2. Overview of Cruise Underway Observations, Surface Data and Remote Sensing (*Philippe Tortell*)
- 3. Status of common data sets (e.g. CTD, TSG, nutrient, O<sub>2</sub> etc.) (Kristina Brown)
- 4. Practical considerations regarding data sharing electronic platform (*e.g.* dropbox) and preferred file formats. Other considerations? (*Group Discussion*)
- 5. Transfer of data to GEOTRACES database GDAC (Jay Cullen, Kristin Orians)
- 6. Group summaries (2 3 slides each) with overview of sampling/results to date (*Summaries presented by R. Francois and P. Tortell*)
- 7. Interaction between observations / data producers and modelers what is the current status of the various models, and how can we best feed in our field data to these models? (*Nadja Steiner, Susan Allen*)
- 8. Interactions / synergies with DFO How will DFO use GEOTRACES data / models to support their scientific mission? (*Andrew Ross*)
- 9. Plans for the first data synthesis work shop in 2016
- 10. Preliminary discussion regarding joint publications (Group Discussion)