

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CANADA

May 1st, 2017 to March 30th, 2018

Accomplishments

The Canadian GEOTRACES group had our second and final synthesis meeting May 23-26, 2017 at the Peter Wall Institute on the University of British Columbia campus. The meeting was hosted by Drs. Philippe Tortell (UBC) and Roger François (UBC). The meeting was organized to bring together the bulk of observations made on our Arctic research expedition completed on two legs aboard the Canadian Coast Guard Ship Amundsen in July-October 2015. Over the three days the project was able to compare and compile observations and experiments from individual PI's and plan for submission of a comprehensive dataset for the GEOTRACES data product. The group continues to coordinate its activities using the UBC Workspace 2.0 cloud based file sharing service that provides secure data management capabilities. PI's François and Jay Cullen (UVic) attended the US Arctic GEOTRACES synthesis meeting in Miami in October 2017. This meeting provided the first opportunity for the two countries to compare data for the purpose of intercalibration as well as synthesize results from their respective expeditions. Canadian PI's continue to work closely with US colleagues and a number of jointly authored manuscripts are planned. The Canadian GEOTRACES community continues to support an ongoing process study making observations of bioactive trace elements and trace element-microbe interactions on time-series cruises completed along Line P in the northeast Pacific. The September expedition of 2018 will be extended using a NSERC Ship Time grant to Roberta Hamme (UVic) and colleagues to allow support of the US EXPORTS project at Ocean Station PAPA. Cullen is coordinating with US colleague Dr. Kristen Buck (USF) to qualify the trace element sampling program for EXPORTS as a GEOTRACES compliant activity.

Our new scientific results, publications and presentations are summarized by Individual Investigator below:

Individual Investigator Reports

Jay T. Cullen, University of Victoria

Refereed Journal Publications: (* denotes HQP)

- Schlitzer, R., et al. (in review) The GEOTRACES Intermediate Data Product 2017. *Chemical Geology*
- *Jackson, S.L., J. Spence, *D.J. Janssen, A.R.S. Ross and J.T. Cullen. (2018) Determination of Mn, Fe, Ni, Cu, Zn, Cd and Pb in seawater using offline extraction and triple quadrupole ICP-MS/MS. *Journal of Analytical Atomic Spectroscopy*, DOI: 10.1039/C7JA00237H
- Smith, J., V. Rossi, K.O. Buesseler, J.T. Cullen, J. Cornett, R. Nelson, A. Macdonald, M. Robert, and *J. Kellogg. (2017) Time series measurements of the transport of the Fukushima radioactivity plume through the northeast Pacific Ocean. *Environmental Science and Technology*, 51(18): 10,494-10,502 DOI: 10.1021/acs.est.7b02712
- Crusius, J., A.W. Schroth, J.A. Resing, J.T. Cullen and R.W. Campbell. (2017) Seasonal and spatial variabilities in northern Gulf of Alaska surface water iron concentrations driven by shelf sediment resuspension, glacial meltwater, a Yakutat eddy, and dust. *Global Biogeochemical Cycles*, 31 doi: 10.1002/2016GB005493

- Posacka A.M., D.M. Semeniuk, H. Whitby, C.M.G. van den Berg, J.T. Cullen, K. Orians and M.T. Maldonado. (2017) Dissolved copper (dCu) biogeochemical cycling in the subarctic Northeast Pacific and a call for improving methodologies. *Marine Chemistry*, <https://doi.org/10.1016/j.marchem.2017.05.007>
- *Janssen, D.J., W. Abouchami, S.J.G. Galer and J.T. Cullen. (2017) Fine-scale spatial and interannual cadmium isotope variability in the subarctic northeast Pacific. *Earth and Planetary Science Letters*, 472: 241-252 doi:<https://doi.org/10.1016/j.epsl.2017.04.048>
- *Schallenberg, C., A. Ross, **A. Davidson, G. Stewart and J.T. Cullen. (2017) Temporal variability of dissolved iron species in the mesopelagic zone at Ocean Station PAPA. *Journal of Marine Systems*, 172: 128-136 <https://doi.org/10.1016/j.jmarsys.2017.03.006>

Conference Presentations (invited):

- Cullen J.T. Uncharted Waters: A scientific glimpse into the future of the Arctic Ocean. (<http://pagse.org/en/breakfasts/Oct%2026%202017.htm>) Bacon and Eggheads, Oct. 26 2017, Parliament of Canada (Centre Block), Parliamentary Dining Room, Ottawa ON Canada.
- Xie, R.C, *D.J. Janssen, W. Abouchami, S.J.G. Galer, M.J.A. Rijkenberg, J.T. Cullen, H.J.W. de Baar, J. De Jong and M.O. Andreae. Controls on upper ocean Cd isotope fractionation. Goldschmidt Conference, Aug. 14 2017, Paris France.
- Cullen J.T., *S. Jackson, *K. Purdon and * D. J. Janssen. The distribution of biologically utilized trace metals in the Arctic Ocean. Canadian Chemistry Conference, Jun. 1 2017, Toronto ON Canada.

Conference Presentations:

- Ross, A.R.S., *D.J. Janssen and J.T. Cullen. Capturing “The Blob”: inter-annual and seasonal variability in dissolved trace metal concentrations along Line P during a recent warm water anomaly in the subarctic NE Pacific, Ocean Sciences Meeting Feb. 11-16, 2018, Portland OR USA.
- De Vera, J.S., P. Chandan, P. Pinedo-Gonzalez, S. John, J.T. Cullen and B.A. Bergquist. Dissolved lead (Pb) isotopes as water and particle tracers in the Arctic Ocean. Ocean Sciences Meeting Feb. 11-16, 2018, Portland OR USA.
- *Jackson, S.L., *K. Purdon,* D. J. Janssen and J.T. Cullen. The distribution of biologically utilized trace metals in the Arctic Ocean. Ocean Sciences Meeting Feb. 11-16, 2018, Portland OR USA.
- *Janssen D.J., W. Abouchami, S.J.G. Galer, *K. Purdon and J.T. Cullen. Particulate Cd isotopes demonstrate a dynamic oceanic Cd cycle. Ocean Sciences Meeting Feb. 11-16, 2018, Portland OR USA.

Céline Guéguen, Trent University

Refereed Journal Publications

- Z. Gao, C. Guéguen 2018. Distribution of thiol, humic substances and colored dissolved organic matter during the 2015 Canadian Arctic GEOTRACES cruises. Marine Chemistry DOI: 10.1016/j.marchem.2018.04.001

Conference Presentations

- C. Guéguen, Y. Gao 2017 Dynamics and sources of dissolved organic ligands in the Canadian Arctic Archipelago. 100th Canadian Chemistry Conference, Toronto, May28-June01, 2017.

Media Coverage and Outreach Activities

- C. Guéguen 2017. La science à bord d'un brise-glace dans l'Arctique Canadien, Ecole francophone Monseigneur Jamot, Peterborough (two talks: JK-Grade2 and Grade3-Grade8)

Dr. Chris Holmden – University of Saskatchewan

Conference Presentations

- Goldschmidt 2016: Chromium isotope variability in modern ocean (I. Baconnais, C. Holmden, R. François)
- Goldschmidt 2018: Investigation of chromium isotope variability in the Canadian Arctic Archipelagos (I. Baconnais, C. Holmden, R. François)

Markus Kienast, Dept. Oceanography, Dalhousie University

Conference Presentations

- Lehmann N, KIENAST M, Granger J, Bourbonnais A, Altabet M, Tremblay J-E (2018) On the origin of the deep N deficit in Baffin Bay: Insights from isotopic signatures of nitrate and nitrous oxide. Goldschmidt Conference 2018, Boston, MA, USA
- Lehmann N, KIENAST M, Granger J, Bourbonnais A, Altabet M, Tremblay J-E (2018) N cycling in the eastern Canadian Arctic: constraints from dual isotope measurements in nitrate and nitrous oxide. Ocean Science meeting 2018, Portland, Oregon, USA.
- Lehmann N, KIENAST M, Granger J, Bourbonnais A, Altabet M, Tremblay J-E, Spatial variability of d15N and d18O in nitrate and nitrous oxide in the Canadian Arctic: tracing waters from two oceans. ASLO 2017 Aquatic Sciences Meeting, Hawaii, USA

Jody Klymak, University of Victoria

Refereed Journal Publications

- Water mass modification and mixing rates in a 1/12-deg simulation of the Canadian Arctic Archipelago. Hughes, K. G.; Klymak, J. M.; Hu, X.; and Myers, P. G. J. *Geophys. Res.*, 122(2): 803--820. 2017.
- Hughes, K., J. M. Klymak, W. Williams, and H. Melling: Tidally modulated internal hydraulic flow and energetics in the central Canadian Arctic Archipelago, in review *J. Geophys. Res.*

Alfonso Mucci, Department of Earth and Planetary Sciences, McGill University

Research Activities

- We have analyzed several thousand bottle cast samples for a number of conservative and non-conservative tracers (e.g., S, T, $\delta^{18}\text{O}(\text{H}_2\text{O})$, $\delta^{13}\text{C}(\text{DIC})$, TA) and combined those with data (e.g., nitrate, SRP, O₂) acquired by collaborators to identify the properties of source-water types in the study area (Beaufort Sea, Canadian Arctic Archipelago, Baffin Bay/Davis Strait) and estimate the relative contribution of these throughout the water column. These water-mass reconstructions are used by our Canadian Geotraces collaborators to interpret the vertical and horizontal distributions of trace elements and their isotopes (e.g., Varela et al., 2016).
- We have been tracking the temporal evolution of the aragonite compensation depth (ACD) in the waters of the study area over the past decade. Our observations reveal that the surface waters in the eastern Beaufort Sea (Mackenzie Shelf and Amundsen Gulf), part of the Canada Basin and the Queen Maud Gulf are already undersaturated with respect to aragonite, this may have deleterious effects on marine ecosystems, particularly organisms that secrete CaCO₃ skeletons/exoskeletons and shells. The Aragonite Compensation Depth in the Canada Basin and Beaufort Sea is shoaling as Atlantic waters, acidified by uptake of anthropogenic CO₂ in the North Atlantic, intrude at depth in the Arctic Ocean (Luo et al., 2016). Atlantic waters enter the Arctic Ocean through Fram Strait and Norwegian Sea/Barents Sea and reach the Canada Basin in about 20 years.

Refereed Journal Publications

- Mol J., Thomas H., Myers P.G., Hu X. and Mucci A. (2018) Inorganic carbon fluxes on the Mackenzie Shelf of the Beaufort Sea. *Biogeosciences* 15: 1011-1027. <https://doi.org/10.5194/bg-15-1011-2018>.
- Hussherr R., Levasseur M., Lizotte M., Tremblay J.-É., Mol J., Thomas H., Gosselin M., Starr M., Miller L.A., Jarnikovà T., Schuback N. and Mucci A. (2017) Impact of ocean acidification on Arctic phytoplankton blooms and dimethylsulfide production under simulated ice-free and under-ice conditions. *Biogeosciences* 14: 2407-2427. doi:10.5194/bg-14-2407-2017.
- Luo Y., Boudreau B.P. and Mucci A. (2016) Disparate acidification and carbonate desaturation of deep and shallow waters of the Arctic Ocean. *Nature Communications* 7:12821, pp. 1-8.
- Varela D.E., Brzezinski M.A., Beucher C.P., Jones J.L., Giesbrecht K.E., Lansard B. and Mucci A. (2016) Heavy silicon isotopic composition of silicic acid and biogenic silica in Arctic waters over

the Beaufort Shelf and the Canada Basin. *Global Biogeochemical Cycles*. 30: 804-823.

Conference Presentations

- Mol J., Thomas H., Myers P.G., Hu X. and Mucci A. (2018) Inorganic carbon fluxes on the Mackenzie Shelf of the Beaufort Sea. Contributed poster. EGU General Assembly, April 8-13, 2018, Vienna, Austria.
- Maldonado M., Li J., Laroche J., Colombo M., Beaupré-Laperrière A., Oriens K. and Mucci A. (2018) A hypothetical role of manganese-oxidizing bacteria on the distribution of particulate metals in the Canadian Arctic Ocean. Contributed oral presentation, Ocean Sciences Meeting, February 11-16, 2018. Portland, Oregon, U.S.A.
- Beaupré-Laperrière A., Mucci A. Thomas H. (2018) Time Series of Ocean Acidification in the Canadian Arctic Ocean. Contributed poster. Institut Nordique du Québec-Second Northern Research Day, January 24, 2018, McGill Faculty Club, Montreal, QC.
- Marshall N.R., de Vernal A., Mucci A. and Kucera M. (2017) Biogenic carbonate production and preservation in the northwestern Labrador Sea and central Baffin Bay during the Holocene and the Last Glacial Maximum (LGM). Contributed poster presentation, Fall AGU Meeting, December 11-15, 2017, New Orleans, Louisiana, U.S.A.
- Beaupré-Laperrière A., Mucci A. and Thomas H. (2017) Time Series of Ocean Acidification in the Canadian Arctic Ocean. Arctic Change 2017. Contributed poster, December 11-15, 2017, Québec City, Canada
- Beaupré-Laperrière A. and Mucci A. (2017) Complex vertical distributions of aragonite saturation states in the Canadian Arctic Archipelago and eastern Beaufort Sea explained by a water-mass analysis. Contributed poster, 100th Canadian Chemistry Conference and Exhibition, Canadian Institute of Canada, May 28-June 1, 2017, Toronto, ON.
- Marshall N., de Vernal A., Mucci A., Filippova A. and Kienast M. (2017) The Labrador Sea during the Last Glacial Maximum: Calcite dissolution or low biogenic carbonate fluxes? European Geosciences Union General Assembly, Contributed poster presentation, April 23-28, 2017, Vienna, Austria.

Paul Myers, Department of Earth and Atmospheric Sciences, University of Alberta

Refereed Journal Publications

- Hughes, K. G., J. M. Klymak, X. Hu, and P. G. Myers (2017), Water mass modification and mixing rates in a 1/128 simulation of the Canadian Arctic Archipelago, *J. Geophys. Res. Oceans*, 122, 803–820, doi:10.1002/2016JC012235.
- Nathan Grivault, Xianmin Hu & Paul G. Myers (2017) Evolution of Baffin Bay Water Masses and Transports in a Numerical Sensitivity Experiment under Enhanced Greenland Melt, *Atmosphere-Ocean*, 55:3, 169-194, DOI: 10.1080/07055900.2017.1333950
- Jacoba Mol, Helmut Thomas, Paul G. Myers, Xianmin Hu, and Alfonso Mucci (2017), Inorganic carbon fluxes on the Mackenzie Shelf of the Beaufort Sea, *Biogeosciences*, 15, 1011–1027, 2018 <https://doi.org/10.5194/bg-15-1011-2018>

Conference Presentations

- FAMOS 2017 (Woods Hole, US) L. Castro de la Guardia, M. Claret, X. Hu, P. G. Myers, & E.G. Galbraith. Evaluating the importance of nutrient sources to primary production in the Arctic, a high resolution modelling experiment using BLINGv0-NEMO-LIM2 framework (poster) - Won 2nd Prize in HQP Poster Competition (~40-50 HQP posters)
- ESSA 2017 (Tromso, Norway). L. Castro de la Guardia, M. Claret, X. Hu, P. G. Myers, & E.G. Galbraith. A novel biogeochemical module for the NEMO ocean circulation model community, suitable for long-term simulations of ocean primary production and gas exchanges. Ecosystem Studies of Subarctic and Arctic Seas open science meeting 2017 in Tromso Norway. (poster)
- ESSA 2017 (Tromso, Norway). L. Castro de la Guardia, M. Claret, X. Hu, P. G. Myers, & E.G. Galbraith. Modelling the response of phytoplankton to storms. Ecosystem Studies of Subarctic and Arctic Seas open science meeting 2017 in Tromso Norway. (oral)
- Flow through the Canadian Arctic Archipelago: numerical model vs observations: Perspectives and improvements Nathan Grivault and Paul G. Myers. IGR 2018 (talk), Edmonton, April 4th
- Frequency of volume and freshwater events leaving the Arctic Ocean: A numerical study. Nathan Grivault, Laura Castro de la Guardia and Paul G. Myers. Ocean Sciences 2018 (poster): Portland, Feb. 11th-16th 2018
- Canadian Arctic Archipelago sea-ice motion and consequences on ocean transport: numerical errors and potential improvements from the addition of tides. Nathan Grivault, Xianmin Hu and Paul G. Myers. DRAKKAR Meeting (talk): Grenoble (France), Feb. 1st-4th
- Frequency of Volume and Freshwater Events Leaving the Arctic Ocean: A Numerical Study. Nathan Grivault, Laura Castro de la Guardia and Paul G. Myers. IGR 2017, October 2017

Training

- Winter School in Marine Environmental Prediction, Université du Québec à Rimouski (UQAR), March 4th-10 2017

Dr. Andrew R.S. Ross

Research Scientist, Institute of Ocean Sciences, Fisheries and Oceans Canada (DFO)

Assistant Adjunct Professor, Biochemistry and Microbiology, University of Victoria (UVic)

Refereed Journal Publications: 2 in preparation

Conference Presentations: 2

- Ross, A.R.S., Nixon, R.L. 2017. Profiling Marine Copper Ligands in the Arctic using Immobilized Metal-ion Affinity Chromatography and Tandem Mass Spectrometry. 100th Canadian Society for Chemistry (CSC) Conference, Toronto ON, 28-31 May.
- Ross, A.R.S., Janssen, D.J., Cullen, J.T., Spence, J., Simpson, K., Robert, M. 2018. Capturing “The Blob”: Variability in Dissolved Trace Metal Concentrations along Line P During a Warming Anomaly. 19th Ocean Sciences Meeting, Portland OR, 21-26 February.

Summary:

During 2017-18 we used the Cu(II)-IMAC method published in 2016 (Nixon and Ross) to extract copper-complexing organic ligands from all of the samples collected during the Fall 2015 Canadian Arctic GEOTRACES cruise. The resulting depth profiles were presented during the Arctic GEOTRACES Workshop at UBC (May 23-25, 2017) and at the 100th CSC Conference in Toronto (May 28-31, 2017) in a session organized by members of Canadian Arctic GEOTRACES. These profiles constitute the first comprehensive survey of (operationally-defined) Cu ligands across the Canadian Arctic, from the Canada Basin through the CAA to Baffin Bay and the Labrador Sea. A manuscript presenting and interpreting these results in the context of complementary data collected by other GEOTRACES researchers during the same cruise (e.g. dCu, Chl-a, CDOM, nutrients, microbial taxonomy) is currently in preparation.

During the past year we also submitted replicate Cu(II)-IMAC extracts from samples collected during the Arctic GEOTRACES cruise and the Line P Iron Program (a GEOTRACES Process Study) for analysis by high performance liquid chromatography-high resolution mass spectrometry (HPLC-HRMS) at the UVic/Genome BC Proteomics Centre. Preliminary results revealed the presence of organic molecules with the same accurate mass/elemental composition and relative abundance in replicate IMAC extracts from the same location and depth. Elemental compositions suggest that these compounds contain O, N and/or S atoms capable of forming functional groups that can bind Cu²⁺ (and, possibly, other metal ions). Similar samples have been submitted to fellow GEOTRACES researcher Celine Gueguen at Trent University for further HRMS experiments involved tandem mass spectrometry (MS/MS) and the addition of copper to form complexes with the extracted ligands. Detection and identification of such complexes using parallel molecular (ESI-MS/MS) and elemental (ICP-MS) analysis is also being investigated.

Some IMAC extracts have been submitted to Hannah Whitby at the University of Brest for voltammetric analysis in order to measure the concentrations and Cu-binding strengths of the recovered ligands. To help identify which species of phytoplankton/cyanobacteria produce copper ligands, and to generate sufficient quantities of these ligands for characterization and identification using MS and other techniques, we also plan to perform culture experiments in 2018/19 using large volume bioreactors now being installed at the Institute of Ocean Sciences.

Results from all these experiments are expected to shed new light on the structures, identities and ecological roles of marine Cu ligands in the NE Pacific and Arctic Oceans.

Filtered seawater samples collected as part of the Line P GEOTRACES Process Study have also been analysed for several trace elements (Mn, Fe, Co, Ni, Cu, Zn, Cd and Pb) using a recently published method (Jackson et al., 2017). The goal was to study changes in the distributions of these elements during a warm water anomaly (the 'Blob') that occurred in the subarctic NE Pacific between 2012 and 2016. Dissolved Fe, Cu, Ni, Co and Cd were significantly depleted in surface waters along Line P during the intense stratification associated with the 'Blob'. Results were presented at the Ocean Sciences Meeting in Portland, OR (February 21-16, 2018) and at the annual Line P Workshop at the Institute of Ocean Sciences in Sidney, BC (March 20, 2018). A manuscript describing these results and interpreting them in the context of changes in plankton ecology and other oceanographic parameters (T, S, major nutrients) is currently in preparation.

We intend to submit these data to the GEOTRACES/BODC database once this is done.

References:

Nixon, R.L., Ross, A.R.S. 2016. Evaluation of immobilized metal-ion affinity chromatography and electrospray ionization tandem mass spectrometry for recovery and identification of copper(II)-binding ligands in seawater using the model ligand 8-hydroxyquinoline. *Frontiers in Marine Science*

3: 246. doi: 10.3389/fmars.2016.00246 (Marine Biogeochemistry Research Topic: Organic ligands - A key control on trace metal biogeochemistry. Sponsored by SCOR Working Group 139).

Jackson, S.L., Spence, J., Janssen, D. J. J., Ross, A. R. S., Cullen, J. T. 2017. Determination of Mn, Fe, Ni, Cu, Zn, Cd and Pb in seawater using offline extraction and triple quadrupole ICP-MS/MS. *Journal of Analytical Atomic Spectroscopy*. doi: 10.1039/C7JA00237H

John N. Smith, Head, Atlantic Environmental Radioactivity Section, Bedford Institute of Oceanography, Fisheries and Oceans Canada, 1 Challenger Dr., Dartmouth, NS Canada B2Y 4A2

Summary:

On March 11, 2011, an earthquake-triggered tsunami off Japan severely damaged the Fukushima Dai-ichi Nuclear Power Plants resulting in the release of 15-20 PBq of ^{137}Cs in the greatest accidental discharge of radioactivity that has ever occurred directly into the ocean. The large inventory of radioactivity spread rapidly eastward across the ocean during the following five years and is now almost entirely resident in the eastern North Pacific. During 2017-18, continuing time series measurements of ^{129}I , ^{134}Cs and ^{137}Cs in seawater were carried out on samples collected in August, 2017 on a cruise of the CCGS Tully on Line P, an oceanographic section extending 1500 km westward from the British Columbia (BC) coastline. Large volume water samples were also collected by a University of Victoria student under the supervision of J. Cullen during the CCGS Laurier cruise on a transect from BC to Alaska in July, 2017. ^{129}I measurements on seawater samples collected in 2016 mainly indicate the presence of fallout-derived ^{129}I on Line P, although there are reports of a significant Fukushima ^{129}I signal that will continue to be investigated. This monitoring program sponsored by DFO and InFORM represents the major international effort to document the transport history of the Fukushima signal through the northeast Pacific Ocean. Fukushima derived ^{134}Cs was first observed at the westernmost station on Line P in the interior of the subpolar gyre in June 2012, about 1.3 years after the accident. By June 2013 the Fukushima signal had spread eastward at very low levels onto the Canadian continental shelf and by August 2014 had increased at the western end of Line P to a value of 5 Bq/m^3 , four times the fallout background from atmospheric nuclear weapons tests. Fukushima ^{137}Cs levels continued to increase through 2016 to values of $6\text{-}8 \text{ Bq/m}^3$ as the Fukushima plume spread eastward on Line P at variable speeds depending on proximity to the core of the Alaska Current. By February and August, 2017 Fukushima ^{137}Cs levels had begun to level off and very slightly decline by a factor of about 10% compared to 2016 maximum values. This result is in agreement with ocean circulation model predictions (Smith et al., 2017) that future levels of Fukushima ^{137}Cs off the BC coast will begin to decline in 2017-2018 in the upper 200 m and approach levels close to the fallout background of about 1 Bq/m^3 by 2021. Although present levels of ^{137}Cs in the eastern North Pacific from Fukushima inputs represent a return of eastern North Pacific seawater concentrations to the fallout levels that prevailed during the 1970s, they do not represent a radiological threat to human health or the environment.

Refereed Journal Publications

- Buesseler, K., Dai, M., Aoyama, M., Benitez-Nelson, C., Charmasson, S., Highley, K., Maderich, V., Masque, P., Oughton, D. and J.N. Smith, 2017. Fukushima Daiichi–Derived Radionuclides in the Ocean: Transport, Fate, and Impacts. *Annual Reviews Marine Science* 9:173-203.
- Smith, John N., Vincent Rossi, Ken O. Buesseler, Jay Cullen, Jack Cornett, Richard Nelson, Alison M. Macdonald, Marie Robert, and Jonathan Kellogg, 2017. Recent Transport History of

Fukushima Radioactivity in the Northeast Pacific Ocean. *Environ. Sci. Tech.*, DOI: 10.1021/acs.est.7b0271.

Conference Presentations (invited)

- J.N. Smith, Transport of Fukushima radioactivity to the Eastern North Pacific, Sept 22, 2017; Plenary Presentation. 2017 Annual PICES Meeting, Vladivostok, Russia, Sept 20-27, 2017

Conference Presentations

- J.N. Smith, Marine applications of nuclear fuel reprocessing tracers in the global ocean. 2017 Goldschmidt Conference, Paris, France, August 12-18, 2017.
- Smith, J.N.; Casacuberta, N.; Christl, M.; Vockenhuber, C.; Cornett, J.; Kenna, T.; Guilderson, T. Synoptic tracer ¹²⁹I sections across the Arctic Ocean from the 2015 German, US and Canadian GEOTRACES cruises. Ocean Sciences Meeting, Portland, Oregon, February 10-16, 2018

Media Coverage and Outreach Activities

- SCOR Training Course on Marine Radioactivity, Paris, France August 11, 2017,
- J.N. Smith, Artificial radionuclides from Fukushima used as tracers of marine processes,
- Media interviews on radioactivity transport: BBC, London Times, Christian Science Monitor.

Philippe Tortell, Earth and Ocean Sciences, University of British Columbia

Refereed Journal Publications

- Jarnikova T., Dacey J., Lizotte M., Levasseur, M. and P. Tortell. 2018. The distribution of methylated sulfur compounds, DMS and DMSP, in Canadian Subarctic and Arctic waters during summer, 2015. *Biogeoscience*. doi.org/10.5194
- Hoppe, CJM; Schuback, N; Semeniuk,; Giesbrecht, K; Mol, J; Thomas, H; Maldonado, MT; Rost, B; Varela, DE; Tortell, PD. 2018. Resistance of Arctic phytoplankton to ocean acidification and enhanced irradiance. *Polar Biology* Volume 41(3) p. 399-413.
- Hoppe, C, Schuback, N, Semeniuk D., Giesbrecht K., Mol J., Thomas H., Maldonado M., Rost B., Tortell P. Compensation of Ocean Acidification effects in Arctic phytoplankton assemblages. 2018. *Nature Climate Change*, accepted, NCLIM-17081528B\

Conference Presentations

- 2018, ALSO / AGU Ocean Sciences Meeting (Portland, Oregon). Influence of mixing dynamics on net community production and CO₂ uptake in Canadian Arctic and Subarctic ocean waters: P D Tortell, R Izett, M Chanona, J L Thibault, P G Myers
- 2018, ALSO / AGU Ocean Sciences Meeting (Portland, Oregon). Biogeochemical and physical controls on interannual and spatial variability in CH₄ and N₂O distributions across the North American Arctic Ocean: C C Manning, D W Capelle, L Fenwick, E Damm, P D Tortell

Diana Varela, University of Victoria

During the 2015 Canadian Arctic GEOTRACES, our group conducted primary productivity experiments that involved 24-hr incubations throughout the euphotic zone using ¹³C, ¹⁵NO₃, ¹⁵NH₄, and ³²Si isotopic tracers. We also collected samples for particulate silica concentrations and the natural abundance of silicon isotopes. Phytoplankton productivity experiments were only conducted on the first leg of the 2015 Canadian Arctic Geotraces cruise, whereas samples for particulate silica concentrations and silicon isotopes were collected on both legs of the cruise. Analysis has been completed for all samples with the exception of the silicon isotope samples, for which analysis is currently underway.

Concentrations of bSiO₂ and rates of Si utilization exhibited subsurface maxima, and followed similar spatial patterns, with a general increase from east to west. Subsurface maxima in C and NO₃ utilization rates were less consistent, whereas high NH₄ utilization rates always occurred at the bottom of the euphotic zone where NH₄ concentrations increased. Both C and NH₄ utilization rates showed the opposite trend to Si, with a decrease from east to west, while NO₃ utilization rates showed little spatial variability. Initial results for Si isotopes potentially reflect Si utilization in modified Pacific water as this water mass travels from east to west through the Canadian Arctic Archipelago. This observation is supported by the eastward decrease in Si utilization rates and Si(OH)₄ concentrations in the same direction.

Refereed Journal Publications

- Hoppe, C.J.M., N. Schuback, D. Semeniuk, K. Giesbrecht, J. Mol, H. Thomas, M.T. Maldonado, B. Rost, D.E. Varela, and P.D. Tortell (2017) Resistance of Arctic phytoplankton to ocean acidification and high irradiance. *Polar Biology*. doi:10.1007/s00300-017-2186-0.
- 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*, doi:10.1002/2015GB005277.

Conference Presentations

- Varela, D.E., Giesbrecht, K.E., de Souza, G.F, and Maden, C. (2018) From the Bering Sea to Baffin Bay: Biogenic Silica Production and Natural Silicon Isotopic Signatures across the Arctic Ocean. (Talk). AGU Ocean Sciences Conference, Portland, OR, USA.
- Giesbrecht, K.E. and Varela, D.E. (2017) Tracing biological silicon utilization in Arctic surface waters using Si incubation experiments and natural variations of Si isotopes. (Talk). *Isotopes in Biogenic Silica (IBiS) Conference*, Blanes, Spain.
- Giesbrecht, K.E. and Varela, D.E. (2017) Silicon Biogeochemistry in Arctic waters during 2015 Canadian Geotraces: Biogenic silica production and natural silicon isotopic signatures. (Talk). *Canadian Arctic GEOTRACES Workshop*, Vancouver, Canada.
- Timmerman, A., Giesbrecht, K.E., Shuback, N., Li, J., Hamme, R.H. Varela, D.E., Maldonado, M., and Tortell, P. (2017) Primary Productivity during 2015 Canadian Arctic Geotraces. (Talk). *Canadian Arctic GEOTRACES Workshop*, Vancouver, Canada.
- Varela, D.E., and Giesbrecht, K.E. (2017) Silicon Biogeochemistry in Arctic and Sub-Arctic waters during 2015 Canadian Geotraces: Biogenic silica production and natural Si isotopic signatures. (Talk). *ASLO Aquatic Sciences Conference*, Honolulu, HI, USA.
- Timmerman, A., Hamme R.H., Miller L.A., Francois R., Soon M., Giesbrecht K., and Varela, D.E. (2017) Spatial Variability of Carbon Export from the Sub-Arctic to the Arctic Ocean. (Talk) *ASLO Aquatic Sciences Conference, Honolulu, HI, USA*.
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