

## Report for the year 2016 and future activities

### SOLAS Canada

**compiled by: Jon Abbatt, University of Toronto**

*This report has two parts:*

- **Part 1:** reporting of activities in the period of January 2016 – Jan-Feb 2017
- **Part 2:** reporting on planned activities for 2017/2018 and 2019.

*The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan.*

**IMPORTANT:** *May we remind you that this report should reflect the efforts of the SOLAS community in the entire country you are representing (all universities, institutes, lab, units, groups, cities)!*

### PART 1 - Activities from January 2016 to Jan/Feb 2017

#### 1. Scientific highlight

*Describe one scientific highlight with a title, text (max. 200 words), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in international collaboration. (If you wish to put more than one, feel free to do so).*

**Dynamic summertime DMS cycling in the Arctic related to sea-ice processes** (Levasseur and Lizotte, Laval U)

Sea-ice dynamics exert a strong influence on arctic microbial communities and their production of the climate-active gas dimethylsulfide (DMS) in the Arctic. High-frequency measurements made in summer 2016 using an automated instrument (ACT-MIMS) during an oceanographic campaign in the Canadian Arctic Archipelago corroborates the hypothesis suggesting that the Arctic Ocean is a nexus of biogenic DMS production associated with diversified niches linked with dynamic sea-ice during the productive season. Results reveal that microbial communities thriving in marginal ice zones significantly contribute to reservoirs of DMS. Furthermore, waters underlying sea-ice are as rich in DMS as their ice-free counterparts suggesting potentially important pulsed fluxes of DMS during ice break-up and the establishment of leads and cracks. High DMS concentrations were measured while transiting through a giant decaying ice floe suggesting that strong haline stratification under melting floes may result in the entrapment of microbial communities within highly irradiated under-ice waters and a resulting up-regulation of photo-protective mechanisms including DMS production. Large variability in DMS and strong near-surface DMS gradients were detected across hydrographic fronts and transitional areas between open water and oceanic inlets and fjords. Further investigation and monitoring of these near-terrestrial regions is needed to

substantiate the suggestion that they may represent significant emitters of DMS during summer.

Citation: M Lizotte, M Levasseur, G Massé, R Bénard, M Gosselin et al. (in preparation). Large-scale spatial distributions of near-surface concentrations of DMS during summer in the Arctic Ocean.

**2. Activities/main accomplishments in 2016 (projects, field campaigns, events, model and data intercomparisons, capacity building, international collaborations, contributions to int. assessments such as IPCC, interactions with policy makers or socio-economics circles, etc.)**

Individual accomplishments/activities are indicated below (PI name in brackets):

- Laboratory experiments on the role of sea ice in CO<sub>2</sub> drawdown. A Canadian-Swiss collaboration (Institute of Ocean Sciences and ETH Zurich) are examining the impact of sea-ice formation rate on CO<sub>2</sub> export with rejected brines using temperature-controlled experiments. (Miller)
- Launch of Biogeochemical Exchange Processes at Sea-Ice Interfaces (BEPSII) as an international research coordination body under the joint sponsorship of SOLAS, CliC, IASC, and SCAR. The first meeting was held in Paris, March 16-18, 2016, to develop the new program and terms of reference. Canadian leadership includes 1 co-chair and 1 additional member of the steering committee. (<https://sites.google.com/site/bepsiiwg140/home>; Twitter @BEPSII\_seaice) (Miller)
- New SCOR working group, #152, on Measuring Essential Climate Variables in Sea Ice (ECV-Ice). This new international working group (with three Canadian members, including a co-chair) is focused on designing and conducting intercalibration experiments on the methods used to study sea-ice biogeochemistry, towards the ultimate goal of establishing best practices for the community. Linked to BEPSII. (Miller)
- International capacity building: IOS hosted an intern from the Polytechnic University of Sinaloa, Mexico, who acquired direct experience conducting research in marine carbon cycling, air-sea exchange, and sea-ice biogeochemistry. (Miller)
- GreenEdge oceanographic cruise June-July 2016, Baffin Bay (3 week participation of M. Galí) (Levasseur/Lizotte)
- Joint NETCARE/ArcticNet oceanographic cruise July-August 2016, Canadian Arctic Archipelago. This was a large research endeavor motivated by multiple scientific goals including better understanding of Arctic DMS dynamics in the ocean, DMS in the atmosphere, primary and secondary aerosol, ammonia sources, CCN, INPs, properties of the ocean microlayer, fog and precipitation characterization (Multiple PIs – Abbatt, Bertram, Chang, Levasseur/Lizotte, Gosselin, Norman, Murphy)
- Research cruise on R/V Endeavour (Sep 25 – Oct 25, 2016) in North Atlantic to study the role of primary marine organic aerosol on the ocean carbon cycle (PI – Dave Kieber, SUNY Albany) (Chang)
- On-going studies of properties of artificially-generated primary marine aerosol from water sampled from the Atlantic Zone Monitoring Program (Mar 2016 & Sep 2016) off the coast of Nova Scotia (PI – Andrew Cogswell, DFO) (Chang)

- On-going studies of the hygroscopic properties of sea-water (Chang)
- Coastal fog study in Sambro, Nova Scotia (May – July 2016) to study effects of marine aerosol on visibility and fog (Chang)
- During the spring 2016, we carried out a 1-month long field campaign at Alert, Canada, to determine concentrations and size distributions of ice nucleating particles in the region. We have also been focusing on writing and analysing INP data collected in the Arctic during 2014-2016 (Bertram)
- We conducted a field campaign at Alert, NU, jointly between University of Toronto and Environment and Climate Change Canada, to investigate the nature of aerosol, ammonia, and VOCs in that remote environment. The campaign was in mid-summer and marine signatures were examined (Abbatt, Liggio, Leaitch, Murphy)

### 3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

N. Steiner, C. Deal, D. Lannuzel, D. Lavoie, F. Massonnet, L.A. Miller, S. Moreau, E. Popova, J. Stefels, and L. Tedesco, 2016. *Elem. Sci. Anth.* **4**: 000084, doi: 10.12952/journal.elementa.000084. What sea-ice biogeochemical modellers need from observers.

Ghahremaninezhad R, Norman A-L, Abbatt JPD, Levasseur M, Thomas JL (2016). Biogenic, anthropogenic and sea salt sulfate size-segregated aerosols in the Arctic summer. *Atmos.Chem. Phys.* 16:5191-5202.

Hussherr R., Levasseur M, Lizotte M, Tremblay JE, Mol J, Thomas H, Gosselin M, Starr M, Miller LA, Jarnikova T, Schuback N, Mucci A (2016). Impact of ocean acidification on Arctic phytoplankton blooms and dimethylsulfide production under simulated ice-free and under-ice conditions. *Biogeosciences Discussions* DOI 10.5194/bg-2016-501

Mungall EL, Croft B, Lizotte M, Thomas JL, Murphy JG, Levasseur M, Martin RV, Wentzell JJ B, Liggio J, Abbatt JPD (2016). Dimethyl sulfide in the summertime Arctic atmosphere: measurements and source sensitivity simulations. *Atmospheric Chemistry and Physics*, 16(11): 6665-6680, DOI 10.5194/acp-16-6665-2016.

Vergara-Temprado, J, Wilson, TW, O'Sullivan, D, Browse, J, Pringle, KJ, Ardon-Dryer, K, Bertram, AK, Burrows, SM, Ceburnis, D, DeMott, PJ, Mason, RH, O'Dowd, CD, Rinaldi, M, Murray, BJ, Carslaw, KS, 2016, Contribution of feldspar and marine organic aerosols to global ice nucleating particle concentrations, *Atmospheric Chemistry and Physics Discussions*, doi:10.5194/acp-2016-822

### 4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

- Daniel Kunkel and Heiko Bozem, Institute for Atmospheric Physics, Johannes Gutenberg University, Mainz, Germany. Calculation of Flexpart trajectories over the Canadian Arctic in summer 2016, for the NETCARE cruise
- Several of our publications are co-authored with researchers at Environment and

Climate Change Canada, including modelers at the Canadian Centre for Modelling and Analysis.

## **PART 2 - Planned activities from 2017/2018 and 2019**

### **1. Planned major field studies and collaborative laboratory and modelling studies, national and international (incl. all information possible, dates, locations, teams, work, etc.)**

- Joint ArcticNet/Sentinel North oceanographic cruise in the Canadian Arctic Archipelago (July 6 -August 17, 2017)
- Greenland Circumnavigation oceanographic cruise summer 2018 in collaboration with ArcticNet and Sentinel North projects (Canada First Research Excellence Fund).
- GESAMP WG 38 community paper "*Changing ocean acidity as a modulator of atmospheric biogeochemistry and climate*" (to be submitted to PNAS, October 2017).
- NETCARE Arctic DMS modelling community paper. Reassessing the climatic role of DMS in the Arctic by integrating new in situ measurements, remote sensing models, and prognostic models of the ocean, ice and atmosphere.

### **2. Events like conferences, workshops, meetings, schools, capacity building etc. (incl. all information possible)**

- The Cryosphere and Atmospheric Chemistry (CATCH) Emerging IGAC activity on chemistry, biology and physics in cold regions, April 19-20 Guyancourt, France. (Participation of scientists - M. Lizotte, J. Murphy, M. Willis)
- Canadian Meteorological and Oceanographic Society's (CMOS) 51<sup>st</sup> Congress and annual meeting, June 4-8 June 2017, Toronto, ON, Canada. (Participation of M. Lizotte)
- NETCARE final workshop on 'The Status and Future of Arctic Aerosol Research', Toronto, Canada, November 13-14, 2017 (Participation the full NETCARE community and 12 international invited speakers)
- Canadian Society for Chemistry annual meeting, Toronto, May 2017, special session on "Arctic Chemistry and Biogeochemistry" (organized by Wang and Murphy)

### **3. Funded national and international projects / activities underway (if possible please list in order of importance and indicate to which part(s) of the SOLAS 2015-2025 Science Plan and Organisation (downloadable from the SOLAS website) the activity topics relate – including the core themes and the cross cutting ones)**

- 2017-2020 BOND (Beacons of Northern Dynamics: developing light-based sensing technologies to monitor climate active gases in a mutating Arctic), a Sentinel North project (Canada First Research Excellence Fund). Relevant to SOLAS 2015-2025

Science Plan Core Themes 1 and 4.

- 2015-2018. ArcticNet funded project “Marine biogeochemistry and surface exchange of climate active gases”. Relevant to SOLAS 2015-2025 Science Plan Core Themes 1 and 4.
- 2012-2017 NETCARE, Network on Climate and Aerosols: Addressing Key Uncertainties in Remote Canadian Environment. Relevant to SOLAS 2015-2025 Science Plan Core Themes 1 and 4.

**4. Plans / ideas for future projects, programmes, proposals national or international etc. (please precise to which funding agencies and a timing for submission is any)**

- We are anticipating a new call for proposals from NSERC’s Climate Change and Atmospheric Research Program, which has funded NETCARE
- An effort is underway to get a Canadian Antarctic program underway

**5. Engagements with other international projects, organisations, programmes etc.**

- BEPSII/ECV-Ice annual meeting: La Jolla, California, April 3-5, 2017
- Participation in CATCH (the Cryosphere and Atmospheric Chemistry), an emerging activity from IGAC. Workshop in Paris in April 2017

**Comments**

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