An Interdisciplinary Assessment of Climate Change Impacts on the Arctic Ocean

A Peter Wall Institute for Advanced Studies Exploratory Workshop

University of British Columbia

May 2-4, 2012

Vancouver, BC

Canada

Final report

Financial support from:

Peter Wall Institute for Advanced Studies (PWIAS)
University of British Columbia (UBC)
Vancouver Aquarium
GEOTRACES
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Introduction

The effects of global warming are most obvious in the Arctic, both on land and at sea. On land, ice sheets and glaciers are melting, permafrost is thawing, the flow of rivers is increasing and their chemical composition is changing. In the Arctic Ocean, sea ice is receding and the hydrography, circulation, chemistry and ecosystems are changing rapidly. Locally, these changes affect the livelihood of northern communities. Globally, they affect climate as a result of altered greenhouse gas emissions, ocean circulation and heat transport. As these perturbations accelerate, there is an increasing sense of urgency to document their extent and to understand their consequences. This exploratory workshop assembled a group of Canadian and international Arctic experts with various backgrounds to foster inter-disciplinary collaborations and to initiate a large-scale research program investigating the biological, chemical and physical responses of the Arctic Ocean to climate changes. The three-day workshop consisted of public lectures on the rapidly evolving changes occurring in the Arctic (terrestrial ecosystems and landscape dynamics; permafrost; hydrology; sea ice; ocean circulation, productivity and chemistry), discussions of the impact of these changes on First Nations communities, and a series of closed door plenary sessions and thematic working groups devoted to developing an international, multidisciplinary research program and delineating funding strategies. The workshop was hosted in collaboration with the Vancouver Aquarium, where the team held a public discussion panel examining climate-related impacts facing the Arctic.

Goals of the workshop

We had 3 principal objectives; 1) to bring together an international group of scientists with expertise in various facets of Arctic climate change to stimulate inter-disciplinary exchanges, 2) to coordinate a international Arctic oceanography expedition under the auspices of the GEOTRACES program, 3) to coordinate a letter of intent to the NSERC Climate Change and Atmospheric Research program towards writing a proposal to undertake the Canadian contribution to the international Arctic expedition.

Workshop schedule

The first day of the meeting was devoted to a series of 30 minute plenary talks followed by 10 min of discussion. These talks were presented on a range of subjects related to terrestrial and marine Arctic processes and their sensitivity to climate change. On the first evening of our workshop, we hosted a public discussion panel and Q&A session at the Vancouver Aquarium, with 3 panelists (an oceanographer, a political scientist and a journalist) presenting their views on the most significant implications of climate change in the Arctic.

On the second day, we had presentations from representatives of the GEOTRACES program from several countries (Canada, USA, England, Sweden, and Germany), the Russian Academy of Sciences and the P.P.Shirshov Institute of Oceanology to begin planning our coordinated efforts for a major field campaign in 2015. In the afternoon, the ART (Arctic in Rapid Transition Initiative) initiative was presented to explore possible synergy with GEOTRACES. The ART project (http://www.iarc.uaf.edu/ART) is an integrative, international, interdisciplinary, Pan-Arctic network initiated by early career scientists and endorsed by the International Arctic Science Committee (IASC), whose objectives are aligned with those of Arctic GEOTRACES. ART's main objective is to study the spatial and temporal changes in sea ice cover, ocean circulation and associated physical drivers over multiple timescales to better understand and forecast the impact of these changes on the ecosystems and biogeochemistry of the Arctic Ocean. This was followed by the formation of two working groups (Canada/US coordination in Canada Basin; UK/Germany/Russia coordination in the Eurasian Basin) to start planning particular sections and cruise activities.

In the morning of the final day, two additional working groups were formed (US/Sweden/Russia coordination shelf-basin interactions; UK/Germany/Canada coordination outflow to the Atlantic) and a final plenary session was held in the afternoon to summarize plans for the coordinated international program. In late afternoon, the Canadians worked specifically on a draft letter of intent to be submitted to NSERC to seek funding for the Canadian leg of the international program.

Wednesday May 2, 2012

Plenary

Time	Speaker	Affiliation	Topic
9:00-9:20	P. Tortell	UBC	Introduction
9:20-10:00	E. Carmack	IOS	Climate Connectivities: Roles of the Arctic and Subarctic Oceans in Global Change
10:00-10:40	R. Macdonald	IOS	Organic and inorganic markers of change in Arctic sediments
10:40-11:10	*Coffee Break*		
11:10-11:50	M. Koppes	UBC	Glacier dynamics under the influence of climate and ocean warming
11:50-12:30	R. Holmes	WHRC	Characteristics and Riverine Fluxes to the Arctic Ocean
12:30-13:30	*Lunch*		
13:30-14:10	L. Demina	Shirov Institute	Trace metal biogeochemistry along Russian Arctic estuaries
14:10-15:00	F. Wang	U. Manitoba	Mercury Biogeochemistry in the Arctic Ocean under a Changing Climate
15:00-15:30	*Coffee Break*		
15:30-16:10	G. Henry	UBC	Changes in Arctic terrestrial ecosystems: responses to observed and experimental climate change
16:10-16:50	J. Heath	UBC	Impacts of climate and hydroelectric developments on sea ice ecology
16:50 – 17:20			Pre-dinner reception
17:20			Bus Departs from PWIAS for the Vancouver Aquarium

Public Evening Event, Hosted at the Vancouver Aquarium. 'The Big Melt: What Climate Means for the Arctic'. A Panel Discussion moderated by Tony Penikett (former Premier of the Yukon). Panelists: Dr. Michael Byers (UBC; Political Science), Dr. Eddy Carmack (Institute of Ocean Sciences); Dr. Candis Callison (UBC; School of Journalism) (see http://www.arctic-climate-change.pwias.ubc.ca/public-talk)

Thursday May 3, 2012

Morning – Plenary

Time	Speaker	Affiliation	Topic
9:00- 9:10	R. Francois	UBC	Introduction
9:10- 9:35	R. Anderson	LDEO	International GEOTRACES program
9:35-10:00	D. Kadko	U. Miami	Arctic GEOTRACES – US
10:00-10:25	M. R. vd Loeff	AWI	Arctic GEOTRACES – UK/Germany
10:25-11:00	*Coffee Break*		
11:00-11:30	S. Shapovalov	Russian Acad. Sci.	Arctic GEOTRACES – Russia
11:30-12:00	R. Francois	UBC	Arctic GEOTRACES – Canada
12:00-12:30	P. Andersson	Swedish Museum	Arctic GEOTRACES – Sweden

Afternoon – Plenary/Working groups

Time	Speaker	Affiliation	Topic
13:50-14:15	A. Forest	Laval U.	Arctic in Rapid Transition (ART) Initiative
14:15- 14:30	Plenary	Formation of working groups	
Time	Working groups	Topic	
14:30- 16:00	WG-1	Canada/US coordination in Canada Basin	
14:00- 15:30	WG-2	UK/Germany/Russia coordination in the Eurasian Basin	
15:30-16:00	*Coffee Break*		
16:00-17:00	Plenary	Review of WG-1 and WG-2 discussion	

Friday May 4, 2012

Time	Working groups	Topic
9:00- 9:15	Plenary	Formation of working groups
9:15- 10:30	WG-3	US/Sweden/Russia coordination shelf-basin interactions
9:15- 10:30	WG-4	UK/Germany/Canada coordination outflow to the Atlantic
10:30-11:00	*Coffee Break*	
11:00-12:00	Plenary	Review of WG-3 and WG-4 discussion

13:00-14:30	Wrap-up: Tentative coordinated international GEOTRACES project in 2015
14:30-16:00	Canadian project coordination for CCAR

Outcomes

The main outcomes of the workshop were (1) the coordination of an international GEOTRACES research program in the Arctic Ocean, (2) the coordination of this program with other relevant Arctic projects ("Arctic Great Rivers Observatory" and "Arctic in Rapid Transition", and (3) initiation of the organization of a follow-up workshop in Moscow.

A pan-Arctic GEOTRACES research program:

The workshop provided the foundation for an international pan-Arctic GEOTRACES research program (Fig. 1) involving the simultaneous use of multiple platforms from several countries to provide the broad synoptic coverage that is essential for fully understanding the Arctic Ocean and establishing a baseline for quantifying future changes.

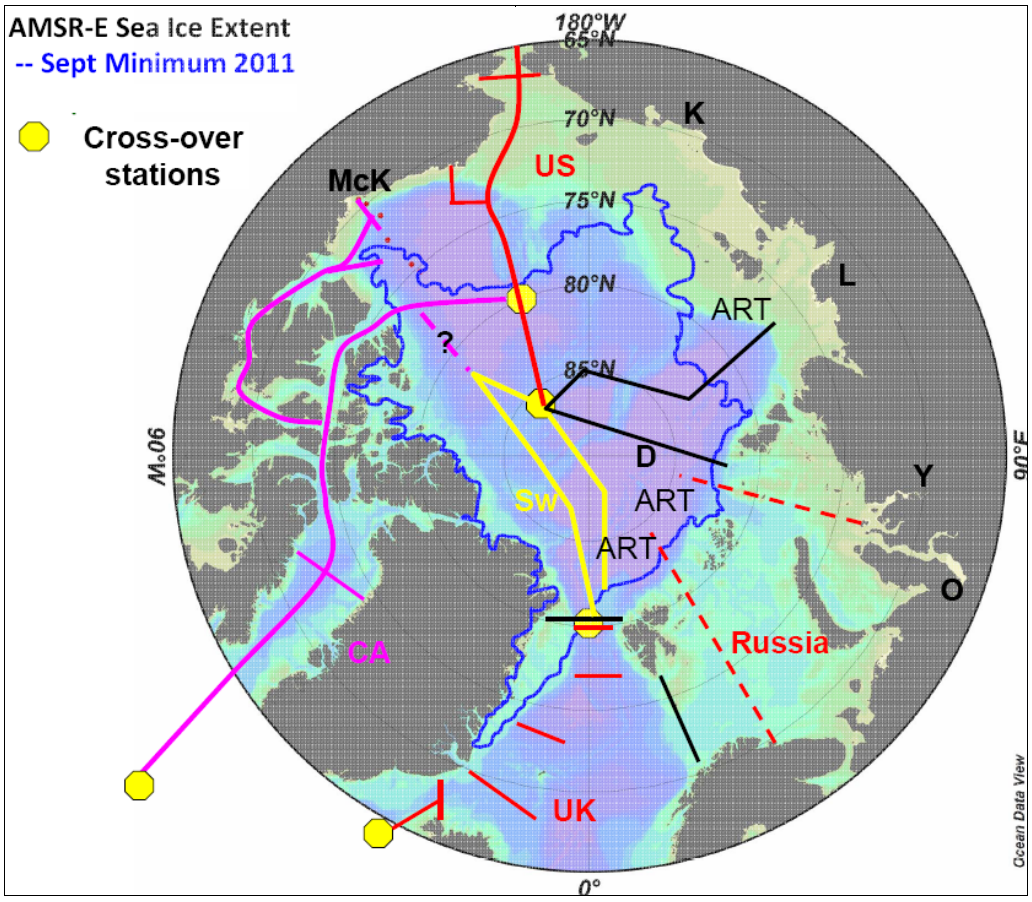

Fig. 1: Tentative cruise tracks for the proposed 2015 international Arctic GEOTRACES program. Proposed national contributions are show in red (US, UK, Russia), magenta (Canada), yellow (Sweden), and black (Germany). Regions of interest for the ART program are also shown. Yellow dots denote cross-over stations to be occupied by more than one national program for cross-calibration. McK, K, L, Y, and O show the location of the major rivers discharging in the Arctic Ocean.

Following the objectives, approach and protocols of the international GEOTRACES program, the Arctic GEOTRACES program would measure a wide range of trace elements and isotopes which play important roles as regulators or tracers of key biogeochemical and physical processes controlling the rapid changes in marine productivity, contaminant dispersion and trace gas emissions presently occurring in the Arctic.
Based on the working group's discussions, we have drawn a map (Fig. 1) showing tentative cruise tracks covering the entire Arctic Ocean. Investigators from each country represented at the workshop will seek funding to complete the different legs as shown on the map. The overall sampling program includes the Pacific inflow through Bering Strait (US), the Arctic outflow to the Atlantic through the Canadian Arctic Archipelago (Canada), exchange between the Arctic and the Atlantic through Fram Strait and the Nordic Seas (Germany & UK), interactions with the Russian shelves and rivers (Russia), and a comprehensive coverage of the deep Canada and Eurasian basins (US, Sweden, Germany, and Canada). Cross-over stations have also been identified (Fig. 1). These are stations that will be occupied by more than one country for the purpose of analytical cross-calibration between national programs and data quality control. If fully implemented, this sampling expedition would involve the simultaneous deployment of ice breakers or ice-reinforced research vessels from 6 different countries (US, Canada, Germany, Sweden, UK, and Russia) across different parts of the Arctic Ocean in 2015, and application of state of the art geochemical tracers to unravel the complex biogeochemical dynamics of the Arctic Ocean and surrounding continental shelf. The program would be unprecedented in scope and scientific breadth.

Coordination between GEOTRACES and Arctic Great Rivers Observatory:

The Arctic Great Rivers Observatory (Arctic-GRO, www.arcticgreatrivers.org), funded by the U.S. National Science Foundation, has been sampling the Arctic's 6 largest rivers (Yenisey, Lena, Ob', and Kolyma in Siberia, Mackenzie and Yukon in North America) since 2003. The focus of this project has been biogeochemical fluxes to the Arctic Ocean. Over the coming years, the trace elements and isotopes of interest to the GEOTRACES community will be increasingly emphasized, thereby providing estimates of fluvial inputs to the Arctic Ocean during the period of the GEOTRACES cruises. Moreover, efforts will be made to obtain samples from smaller rivers as well, including sampling of rivers in the Canadian Archipelago through collaborations between Canadian scientists and Max Holmes (director of the Arctic Great Rivers Observatory).

Coordination between GEOTRACES and ART:

Discussions between representatives of GEOTRACES and the ART network proved very fruitful, in particular, regarding the timeline and logistics of oceanographic campaigns that might take place onboard the RV Polarstern in 2015-2016. The ART Program is planning three cruises focusing on ecological, biogeochemical and geological studies across the Eurasian Arctic margin during the winter-spring and fall-winter seasonal transitions. The German component of GEOTRACES proposes a synoptic large-scale transects from the shelfbreak to the deep Eurasian basins during the annual minimum in

sea ice extent. Proposals from ART and GEOTRACES for ship-time onboard the RV Polarstern in 2015 will be coordinated over the coming months. The participation of ART scientists to the GEOTRACES cruise and vice-versa will further enhance the synergy between the two programs.

A follow-up Arctic GEOTRACES workshop in Moscow:

A key aspect for the success of the overall program is further coordination with the Russian oceanographic community which has on-going sampling programs on the Russian shelves and estuaries of the main Russian rivers discharging in the Arctic Ocean. To that effect, our Russian colleagues who were present in Vancouver have volunteered to organize a workshop in Moscow by the end of this year or next year to promote the GEOTRACES program in Russia, stimulate further interest within the Russian scientific community, and explore possibilities to integrate the study of trace element and isotopes in the Russian exclusive economic zone.

The next steps

A group of scientists from each country represented at the workshop are committed to work towards the realization of the research program in 2015.

Canada:

A Letter of Intent (LOI) has been submitted to NSERC's Climate Change and Atmospheric Research program on May 16, 2012 to write a proposal to complete the Canadian leg identified on Figure 1.

Title: *The Canadian Arctic Geotraces Program: Biogeochemical and tracer study of a rapidly changing Arctic Ocean*

Principal investigators: *Roger Francois (UBC), Philippe Tortell (UBC), Feiyue Wang (U. Manitoba), and Bridget Bergquist (U. Toronto)*

Government Partners: *Svein Vagle (IOS), William Williams (IOS)*
International Partner: *Robert F. Anderson (LDEO)*

The estimated cost is $4.9M over 5 years and involves 15 teams from 9 Canadian universities The LOI has received strong endorsement letters from the Department of Fisheries and Ocean and the Northern Contaminant Program of the Aboriginal Affairs and Northern Development Canada. Both federal agencies view the Canadian Arctic GEOTRACES project as an important complement to their own programs. If selected, invitations to write a full proposal will be sent by August 17, 2012. Deadline for the full proposals is November 9, 2012.

USA:

The US community has already requested 50 days of ship time on the USCGC Healy for 2015. A planning workshop is scheduled for June 13-15, 2012 in Washington DC. A management proposal will be submitted on October 18, 2012. If funded, there will be a general call for proposal to NSF in February 2014.

Germany:

Two proposals will be submitted by August 1, 2012 to use the R/V Polarstern in coordination with the hydrography group of the Alfred Wegener Institute (Ursula Schauer): One proposal will focus on the central Arctic and Laptev Sea in 2015 and the other will consist of sections across Fram Strait (up to the Greenland coast) and from Svalbard to the Norwegian coastline in 2016. Final publication of the Polarstern cruise plan for the period of October 2014 to October 2016 is scheduled is scheduled for fall 2013. If the R/V Oden (Sweden) and R/V Polarstern 2015 expeditions are both funded, they will be closely coordinated.

Sweden:

A project plan proposal for the R/V Oden was approved by the Swedish Research Council (VR) in the autumn of 2010 and endorsed and prioritized by the Swedish Polar Research Secretariat (SPRS) as part of the long-term national Arctic research planning program. Proposals for funding of various components of the cruise, including international collaborations, will be submitted to the Swedish Research Council, the UK national environmental research council (NERC), and the EU in 2013. A proposal for a collaboration with a French group is being submitted (June 2012) under the French-Swedish Common Research and Training Programme on Climate and Environment. Other international collaborations are being discussed.

United Kingdom:

A proposal will be submitted to the Natural Environment Research Council (NERC) for a biogeochemical study with the R/V James Clark Ross in the Greenland Sea. This project will focus on the biogeochemistry of the marginal ice zone, and will also sample for GEOTRACES parameters. The cruise track will include sections perpendicular to the Greenland Coast, Denmark Strait, the accessible part of the Fram Strait and will be closely coordinated with the 2016 R/V Polarstern expedition, as the latter will be able to get closer to the Greenland coast.

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