INTERNATIONAL AIR QUALITY ADVISORY BOARD

Second Expert Consultation Meeting

Air Quality Issues related to the Northern Boundary Region between the United States and Canada

Held at
Best Western Gold Rush Inn
411 Main Street
Whitehorse, Yukon
August 17-19, 2010

DISCLAIMER: Views expressed in this report are those of individual participants and the International Air Quality Advisory Board and are not necessarily those of the International Joint Commission.

Special Thanks

Following the three days of consultations in Whitehorse, Yukon, representatives of the International Joint Commission and the International Air Quality Advisory Board visited The Little Fox Lake's Air Quality Monitoring Station to receive briefings on the Intercontinental Atmospheric Transport of Anthropogenic Pollutants (INCATPA) monitoring site's measurement of toxic chemicals in Arctic air.

Special thanks to Chad Gubala and Haley Hung of Environment Canada for making the arrangements.

Executive Summary of Conference Findings and Recommendations

The International Joint Commission (IJC) and its International Air Quality Advisory Board (IAQAB) convened an expert consultation in Anchorage, Alaska, September 9-10, 2008 to discuss air quality issues related to the northern boundary region between the US and Canada. A second consultation was convened August 17-19, 2010 in Whitehorse, Yukon to continue these discussions. Over 40 participants attended each meeting. The report which follows is a summary of the discussion and findings of the second consultation in Whitehorse. A report of the Anchorage meeting can be found at: http://www.ijc.org/php/publications/pdf/ID1636.pdf.

The key messages emerging from the consultation were grouped into five categories as follows:

1. **Sources**

- Currently northern transboundary air quality impacts from Canadian and Alaskan air emissions are likely minimal; however, as industrial development increases so does the potential for northern transboundary air quality impacts. There is a growing interest in hard rock mining, open pit mining, and more power generation.
- Major local sources of aerosols in Alaska and probably the Yukon include road dust, resource development, diesel generators, and open burning of solid waste. The effects of air pollutants on local resources and human health in the north are not the same as experienced along the southern boundary and will require unique solutions to minimize impacts on the ecosystem and human health.
- Aged polluted air from Asia and from international ship lanes reaches Alaska and what happens to these ship emissions differs from that known for mid-latitudes. Advection of pollutants from ship emissions contributes temporally to SO_2, SO_4^{2-} increases and enhanced ozone advection/formation occurs along the Alaska panhandle. Control of ship emissions is important to mitigate air pollution in the north. The trans-boundary nature of the international aerosols means that international cooperation will be required to reduce the quantities of those aerosols.
- Several toxic contaminants (e.g., POPs and mercury) are transported long range into Alaska and into the Yukon from Asia, Russia and south-western provinces and states in North America. These toxic substances enter the ecosystem and accumulate to high levels in biota (especially marine mammals and fish).

2. **Prevention, Control, Abatement**

- Oil spill damage in the north is something which we should expect as exploration and extraction increase. Conditions at northern spill locations will be much different than experienced in the Deepwater Horizon disaster in the Gulf of Mexico. Ssystems should be developed to prevent an event of this type or magnitude from occurring in the future and tools for appropriate emergency response should be developed, thoroughly tested, and simulated response exercises conducted regularly.

- New energy systems (to replace existing hydrocarbon-based energy generation processes) are very promising but require more research and development and care in implementation. Nevertheless, a cold climate can be a big advantage for some of the systems. Multi-national collaborations/analogues are critical for new systems development.
- Decreasing aerosols from local sources will require local regulatory action, common sense and going after the 'most bang for the buck' sources first.
- Inuit are among the most exposed/affected people of the world with respect to environmental chemicals and need to be included in discussions which affect their future. Global agreements are essential for protecting minority groups and partnerships between the Inuit Circumpolar Conference (ICC) and some national governments and international organizations are a positive model for others to follow.

3. Monitoring and Modeling

- Models and monitoring are complementary. Current models focus on transboundary transport of pollutants, examine urban and global scales, forecast storm surges, sea ice movement, movement of volcanic ash, surface pollutant concentrations and upper level ozone and solar radiation) and simulate movements of smog, acid deposition and air toxics.
- Lichens and passive sensors have been used effectively in the north to evaluate impacts on the ecosystems exposed to pollution from shipping and long-range Eurasian smelters and coal fired generators. Data from 1998-2008 indicate there is significant change in deposition in some areas of Alaska; however, the changes are complex. This monitoring needs to continue.
- Air pollutant issues (e.g., particulates and other aerosols, toxics, NOx and SOx) should be linked with climate change science to better understand changing conditions in the North and how these changes affect transport, fate, deposition and effects of these substances on biota.
- Regular and systematic monitoring activities are critical for the ongoing 'effectiveness evaluation' of international pollution control agreements (e.g., the Stockholm Convention and the POPs and Metals Protocols to the Convention on Long-Range Transboundary Air Pollution).

4. Health Issues

- Many northerners rely on fish as a healthy dietary staple and fish consumption levels are high. Action is warranted to ensure the safety of the food supply of Alaska and the Yukon because of its unique nutritional, cultural, economic importance. Advice to northerners needs to be clear, open and culturally sensitive.
- Concern over toxics in the traditional food supply as well as social pressures are contributing to dietary transitions among northerners and indicate an increase in consumption of store-bought foods which are high in carbohydrates and low in

beneficial fatty acids. Territorial health agencies encourage the continued consumption of traditional foods due to their positive contribution to health. Levels of some toxic substances are declining in traditional foods such as fish and may indicate that global, regional and national controls are slowly reducing deposition of several contaminants in the Arctic and/or that diets are changing.

- Climatic inversions continue to be problematic in several northern communities (e.g., Whitehorse and Fairbanks) which generate significant amounts of particulates through the use of space heating with low cost fuels (wood and coal), automobile, and diesel electric generators.

5. International Cooperation

- The IAQAB should continue to facilitate communications among the interested parties in the North through a series of topical web seminars. Useful topics might include, but not be limited to, particulates and gases from local and international shipping (sources, amounts, seasonality, trans-border movement, abatement, etc.).
- The IAQAB should continue to encourage the US and Canadian jurisdictions, First Nations and Tribes, and academic and non-governmental organizations in the North to maintain a "community of practice" to exchange information and facilitate transboundary policy discussions.
- There might be an opportunity to start some type of cross-border demonstration project, such as joint monitoring for toxic contaminants, even though there is not a formal mechanism under the Air Quality Agreement to support work on toxic contaminants.

List of Abbreviations and Acronyms

AMAP – Arctic Monitoring and Assessment Program
AQA - Agreement between the Government of Canada and the Government of the United States of America on Air Quality
AQC - Air Quality Committee of the Canada-US Air Quality Agreement
CAPMoN – Canadian Air and Precipitation Monitoring Network
CWS - Canada-Wide Standards
DFO – Department of Fisheries and Oceans (Canada)
EC – Environment Canada
EHS - Environmental Health Services of the Alaska Tribal Health Consortium
ENR – Environment and Natural Resources Department (of the GNWT)
EPA - Environment Protection Act (of the GNWT)
GEM – a computer model called Global Environmental Multiscale
GEOSS - Global Earth Observation System of Systems
GNWT - Government of the Northwest Territories
GRAHM – a computer model called Global/Regional Atmospheric Heavy Metals
IAQAB - International Air Quality Advisory Board (of the International Joint Commission)
ICC - Inuit Circumpolar Conference
IJC – International Joint Commission (of Canada and the United States of America)
IMPROVE - Interagency Monitoring of Protected Visual Environments
INAC – Indian and Northern Affairs Canada
INCATPA - Intercontinental Atmospheric Transport of Anthropogenic Pollutants to the Arctic
IPY - International Polar Year
LRTAP - Convention on Long Range Transport of Airborne Pollutants
NAPs - National Air Pollution Surveillance (monitoring stations in Canada)
NCP – Northern Contaminants Program
NOx – Nitrogen oxides (a generic term for gases such as nitrous oxide, and nitrogen dioxide)
NOAA - National Oceanic and Atmospheric Agency
NGO - Non-governmental organization
NHP – National Park Service
NWT - Northwest Territories
PAH – Polyaromatic hydrocarbon
PFOS - perfluooctanylsulfate
PM – Particulate matter (may be PM_{10} – particles between 10 and 2.5 microns; or $PM_{2.5}$ – particles less than 2.5 microns in diameter)
PCB – polychlorinated biphenyl
POP – Persistent organic pollutant
PWS - Prince William Sound
SAON – Sustaining Arctic Observing Networks
SO_2 - Sulfur dioxide (a gas)
SO_4^{2-} - a form of a reactive sulfur containing gas
TC – Transport Canada
UNECE -United Nations Economic Commission for Europe
USEPA - United States Environmental Protection Agency
VOC – Volatile organic compound

Table of Contents

1.0 Introduction

The International Air Pollution Advisory Board (now known as the International Air Quality Advisory Board (IAQAB) was formed by the International Joint Commission in 1966 as part of a reference from governments to address transboundary issues related to Canada /US air quality. The role of the IAQAB is to make recommendations to the Commission who then may make suggestions to policy makers and regulators in the two governments. The IAQAB serves as an independent mechanism to get information to the IJC and to governments to improve transboundary air quality policy. There are five IAQAB members from each country, who are scientific experts and who serve in their personal and professional capacity. Recently, issues such as climate change and sustainability have been linked to air quality. Also, along the entire length of the US/Canada border, energy issues are becoming increasingly important, since the production, use and transmission of energy are fundamentally linked to ecosystem and human health.

On August 17-19, 2010 representatives of the International Joint Commission (IJC) and the International Air Quality Advisory Board (IAQAB), joined technical experts from western Canada and Alaska to discuss issues related to production and transport of air pollutants in the northern transboundary region including Alaska, the Yukon and British Columbia. Two years earlier, the IJC and the IAQAB had met in Anchorage, Alaska (September 9-10, 2008) to consider these same issues. These two meetings in Anchorage and Whitehorse followed previous consultations by the IAQAB in the Washington State/British Columbia border region which had not extended their analysis into the northern transboundary region.

The IAQAB heard from a broad cross-section of technical experts at both the Anchorage and Whitehorse meetings on significant air quality issues associated with local, regional and trans-Pacific sources of air pollutants. The Board also heard from air pollution scientists, public health experts and resource managers in the North about the potential effects of air pollution on forests, fisheries, native communities, human health, visibility and quality of life in this region.

The report which follows provides information and recommendations forthcoming from the Whitehorse meeting. A report of the Anchorage meeting is already available on the IJC website at http://www.ijc.org/php/publications/pdf/ID1636.pdf

2.0 Meeting Proceedings and Synopsis of Presentations

The following is a synopsis of the presentations at the Whitehorse Consultation held August 17-19, 2010.

2.1 DAY 1 (August 17)

US Commissioner Lana Pollack brought greetings from the other five IJC Commissioners. She thanked attendees for the invitation to attend the meeting and her appreciation for Jon Bowen's and John Mayes' commitment to this binational effort. She described the early history of border-related disputes between Canada and the USA during the Klondike Gold Rush and the decision of a joint governmental panel of six members to award the Alaskan panhandle to the USA. This early and controversial 'cooperation' was later codified in two treaties that came in quick succession: the 1908 International Boundary Commission was established to map and maintain the boundary from coast to coast; and the 1909 Boundary Waters Treaty created the International Joint Commission. This short history underscores that the boundaries between Canada and the USA and particularly the northern area under discussion at this meeting have long played an important role in the development of both countries. Those who know the North know its rich heritage filled with stories of great triumphs over the odds - as well as great tragedies - especially in the treatment of native people.

Lana Pollack then directed her comments at the challenges faced in the north today, including the warming of the planet and the impacts of long-range and more local sources of pollution – pollution that is impacting the air, the water and even the land. These major concerns threaten human and ecosystem health. She noted that these issues are receiving considerable scientific study, so that future policy can be crafted in response to better understanding.

She noted further that while the IJC has largely focused on water issues, it also has a long history of considering air quality issues reaching back to the Trail Smelter dispute of the late 1920s through to the role the IJC plays today in the implementation of the 1991 Canada-US Air Quality Agreement. More recently the Commissioners took note of a recommendation from the Anchorage meeting in 2008 to convene a science and policy meeting in Whitehorse. Commissioner Lana Pollack concluded with her delight to be a part of the followup on this recommendation and to have the opportunity to learn from the meeting participants about regional air quality concerns and about what the IAQAB and the Commission might do to help resolve these challenges.

Jon Bowen, Director of Environmental Programs, Environment Yukon welcomed the assembled air quality experts, on behalf of the Yukon Government.

John Mayes, Canadian Section Member of the IAQAB also welcomed the participants on behalf of the Board and Canada. John thanked the attendees at the meeting, noting the

breadth and variety of participants from both sides of the border representing key stakeholders, including representatives from Federal, State, provincial, university, non-governmental organization and First Nations organizations. Building on past IAQAB consultation with representatives of the same stakeholders, John identified two key workshop goals: 1) to deliver a report to Commissioners that provides insight into the challenges, opportunities and considerations associated with transboundary air-related issues, including a sense of the unique issues of this geographic area ; and 2) to provide the impetus and encouragement for the formation of a local cross-boundary network of stakeholders starting with the attendees of this workshop for continued dialogue regarding air quality issues.

Ann McMillan, Canadian co-chair of the IAQAB, reviewed the role of the Board and indicated its commitment to capturing the dialogue at the consultation, reporting it to the Commission, and continuing to promote binational air quality discussions related to the northern border region. She mentioned a white paper provided to participants before the meeting which should be helpful with discussion later in the meeting. A summary of the key points of the white paper can be found in Session V (page 21).

2.1.1 SESSION 1: Setting the Stage

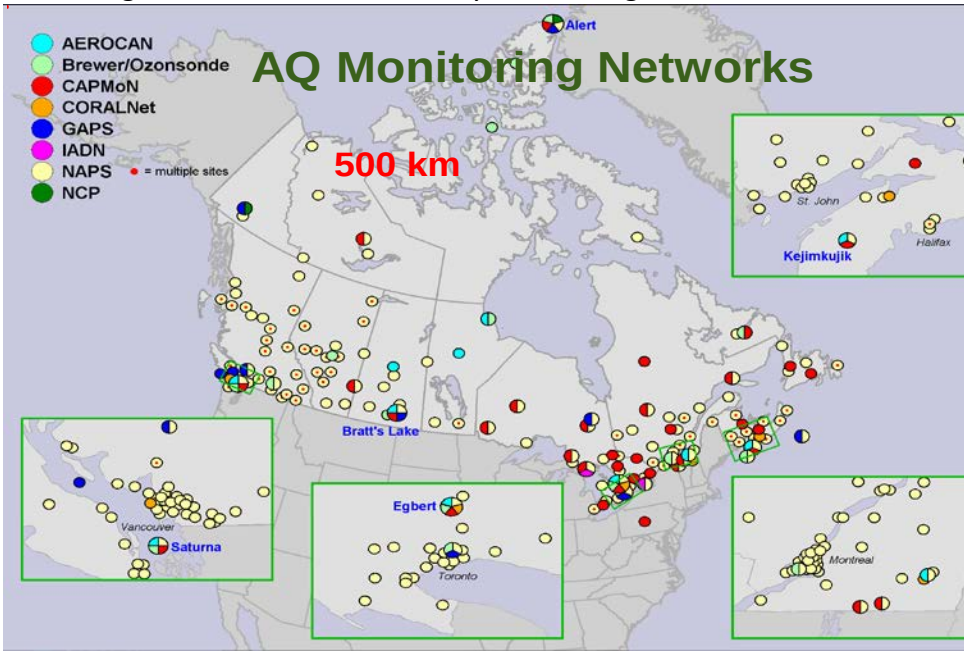
Ann McMillan, Canadian co-chair of the IAQAB, opened the session with an overview of the consultation process. She also reiterated the two goals of the workshop:

(1) delivery of a report to Commissioners; and
(2) creation of a local network for continued dialogue regarding air quality issues.

Dave Fox, Air Pollution Management Analyst, Environment Canada: "Development in Northern Canada"

Dave Fox set the stage for participants with a discussion of northern resource development, monitoring and regional issues. In Canada, the northern territories of Nunavut, the North West Territories and the Yukon make up about 40% of the land mass of Canada but contain only 0.32% of the population. Most major emission sources in Canada are located along the southern boundary, except for some in Alberta. Currently there are few large emission sources along the northern Canada/Alaska boundary. However, there are a number of planned industrial developments in northern Canada and northern B.C. in the mining and oil and gas (onshore and offshore) sectors. There are 28 mines proposed in Canada within 500 kilometres of the Alaska border. There are about 2.5 million hectares of exploration licences issued for offshore oil and gas in the Canadian Beaufort Sea. If the Mackenzie Gas Project is approved and constructed, there will be induced natural gas developments along the Mackenzie Valley and in the Yukon. Air quality measurement sites can be found throughout Canada and some of these sites can be found in the northern regions (Figure 1).

Figure 1: Canadian Air Quality Monitoring Networks



Key issues related to air quality include the requirement for extensive use of air and truck transport to meet community needs, the need for on-site power generation using fossil fuels, and the use of incineration for wastes. Environment Canada has developed a "Technical Document for Batch Waste Incineration" that provide operators with advice on appropriate incineration technologies and best management practices.

The key message from Dave Fox's presentation is that currently northern transboundary air quality impacts from Canadian air emissions are small. However, as industrial development increases so does the potential for northern transboundary air quality impacts.

Rick Artz, Deputy Director, NOAA Air Resources Laboratory: "The Deep Water Horizon Disaster and Emerging Air Issues: Have we learned anything?"

Rick Artz provided an update on the events surrounding the 2010 Deep Water Horizon blow-out in the Gulf of Mexico and the local and remote monitoring used to evaluate some of the movements of the airborne emissions. The Deep Water Horizon blowout (approximately 4.9 million barrels) was one of the world's largest spill events and over 20 times the size of the Exxon Valdez spill. Controlled burning of some of the surface oil led to significant amounts of airborne soot. Both gaseous and aerosol hydrocarbons were observed in the immediate vicinity of the spill and dissipated with distance from the spill centre (aerosol organics spreading further than volatile organics). Some odour and exceedances of the air quality index for ozone and particulates were reported by United States Environmental Protection Agency (USEPA) near human populations on the Gulf Coast, although exceedances were not unequivocally tied to the spill. The National Oceanic and Atmospheric Agency (NOAA) was able to use emissions from the

test burns to model movements of combustion products from the spill areas using a variety of monitoring stations and satellite technology.

Rick Artz concluded that these kinds of events will happen again and that we should expect that conditions at future spill locations may be much different than experienced in the Gulf of Mexico. Many questions remain concerning effects from polyaromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), dispersants, particulate matter (PM), and other air toxic contaminants on spill workers, the general public, marine life, and agriculture. He stressed that: protection of important assets should be considered before the next disaster, not sorted out as events unfold; systems should be developed to prevent an event of this type or magnitude from occurring in the future; and that tools for appropriate emergency response should be developed, thoroughly tested, and simulated response exercises conducted regularly.

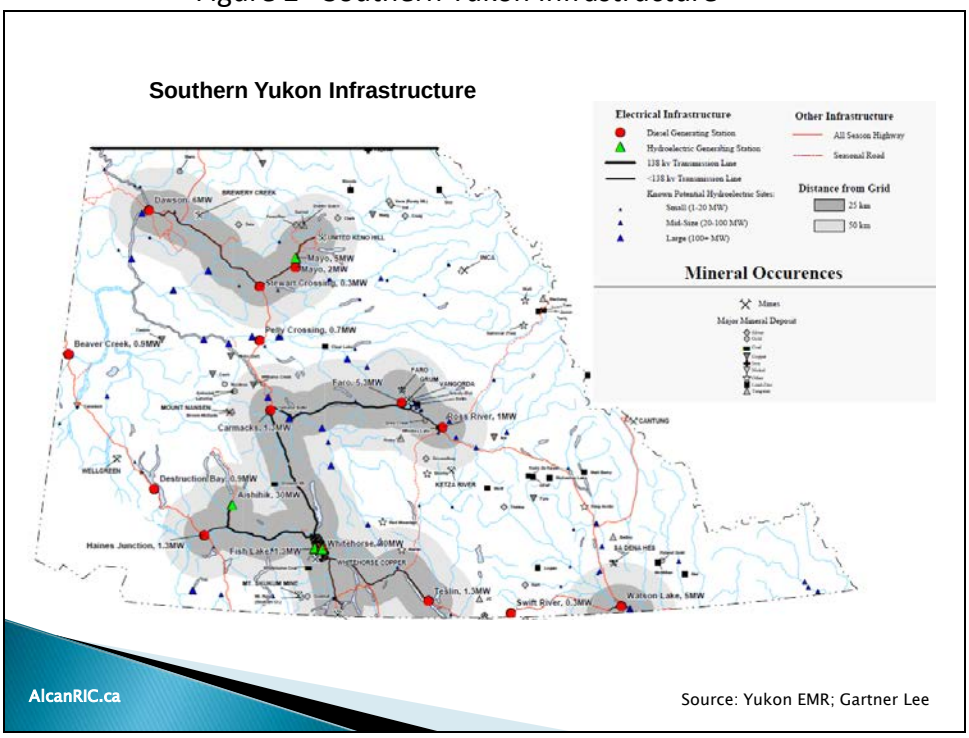
Chad Gubala, Director, Alaska-Canada Research Innovation Centre: "Exploring Opportunities for Alternative Energy Supply in Remote Locations" [the presentation was made by Ann McMillan].

This presentation described the spatial distribution of power demand and power sources (current and potential) in the Yukon and used this as a base for a discussion as to how other sources of energy might be tapped in the region to lessen demand on hydrocarbon-based systems. Pros and cons for several alternative energy sources were provided: a Stirling engine uses heat and cold energy to produce electricity; several hydrokinetic devices can be deployed in moving water to generate electricity; waste can be utilized in gasification and batch oxidation systems to generate electrical energy; and geothermal sources can be tapped in some areas of the northern regions. These technologies (different technologies in different areas) are all being evaluated in the Alaska-Yukon region. Currently, hydrocarbon-based systems are extensively used, well-known (technology and repair) and will take time to be replaced by alternative energy sources. New energy systems are very promising but require more research and development and care in implementation. Nevertheless, a cold climate can be a big advantage for some of the systems. Since the energy industry is resource intensive and changes are slow, multi-national collaborations are critical for new systems development. The diffuse nature of both resources and infrastructure were also discussed and are presented in Figures 2 and 3.

Carl Sidney, Chairman, Yukon River Inter-Tribal Watershed Council: "We live by the river (video documentary)"

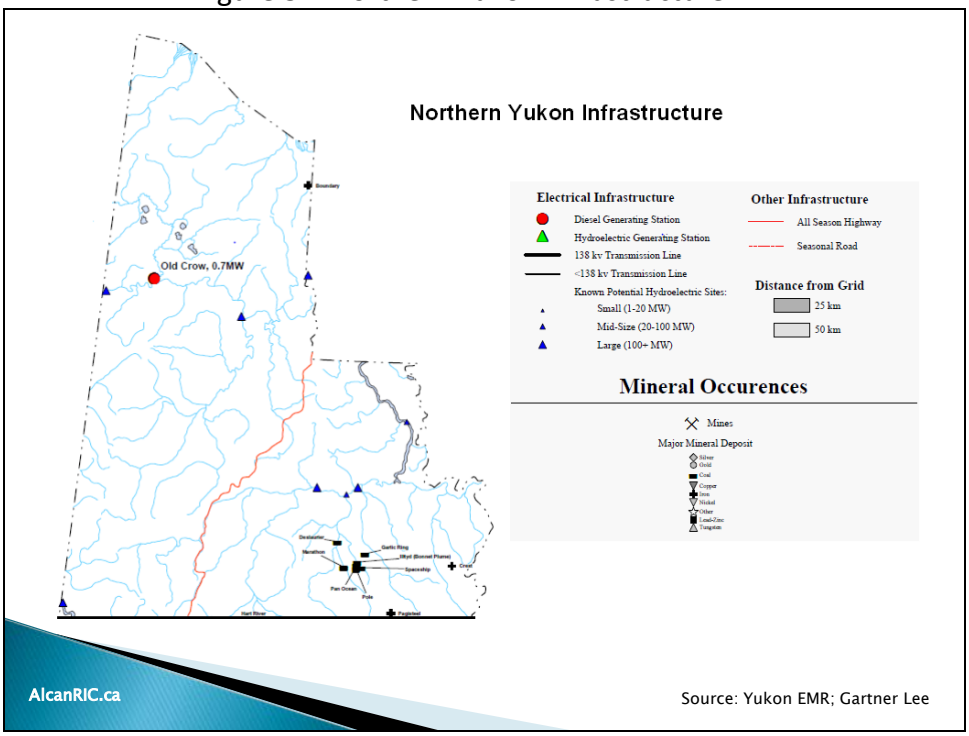
Carl Sidney provided a short introduction to a documentary video which provides insights into life on the river as well as some of the challenges faced to maintain this pristine environment and in some cases, restore it. This documentary can be seen by contacting Carl Sidney at http://www.yritwc.org/

Figure 2– Southern Yukon Infrastructure



Source: Yukon EMR; Gartner Lee

Figure 3 – Northern Yukon Infrastructure



Source: Yukon EMR; Gartner Lee

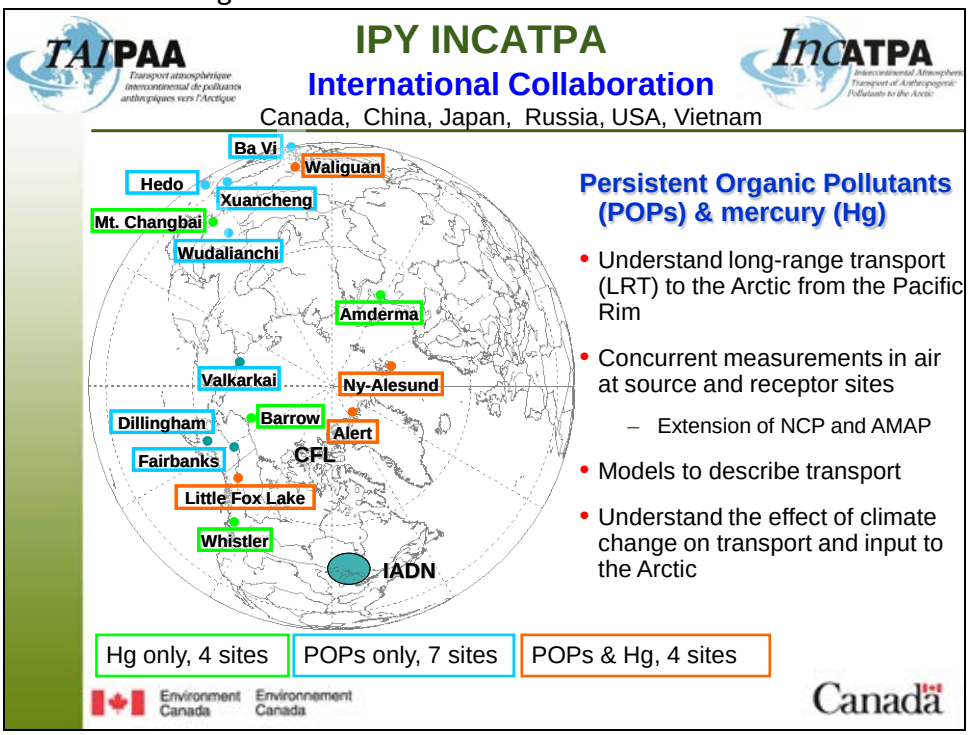
2.1.2 SESSION II: Local and Long–Range Air Pollution Sources

Richard Artz, IAQAB member, facilitated Session II. Considering that long-range air pollutants are of a global scale and affect local and regional air quality and ecosystem health, discussions in Session II focused on how best to provide advice to the IAQAB and ultimately to the IJC and the governments of Canada and the US to jointly formulate and promote strategies and approaches for mitigation at the international level.

Hayley Hung, Research Scientist, Process Research Section, Air Quality Division, Science and Technology Branch, Environment Canada: "Atmospheric Organic Pollutants and Mercury in the Arctic: Recent Findings from the Northern Contaminants Program and the International Polar Year Project of Intercontinental Atmospheric Transport of Anthropogenic Pollutants to the Arctic (INCATPA)"

Hayley Hung described the International Polar Year (IPY) project INCAPTA, which attempted to better understand long-range transport to the Arctic from the Pacific Rim through concurrent air measurements at source and at receptor sites. INCAPTA developed models to describe air transport and considered how climate change could affect the transport and deposition of pollutants to the Arctic. The sites used for the INCAPTA study are shown in Figure 4.

Figure 4 – IPY INCATPA International Collaboration



Measurements taken at the Alert monitoring station have shown that for Lindane (a pesticide controlled under the Stockholm Convention), levels have declined by half over the last 4 years;

however, for endosulfan (under consideration for listing under the Stockholm Convention) there have been no significant declines. Examples of data sets from the Little Fox Lake site in the Yukon, and Dillingham, Fairbanks and Barrow in Alaska indicated the importance of seasonal deposition rates, proximity to sinks such as the Bering Strait, differences between sampling stations with respect to source back trajectories, and the role of physical geography (mountains and forests) in intercepting persistent organic pollutants (POPs) transported into North America. Mercury measurements were also included in the INCAPTA study. The INCAPTA study also found that most mercury is emitted from the Northern Hemisphere and Asia appears to be the largest emitter. However, transport of mercury to the Arctic is more effective from Russian and North American sources. Hayley Hung concluded that the project provides information on time trends, long-range transport and climate change, which is critical for the ongoing 'effectiveness evaluation' of international pollution control agreements (e.g., the Stockholm Convention and the POPs and Metals Protocols to the Convention on Long-Range Transboundary Air Pollution).

Nicole Mölders, Chair of the Department of Atmospheric Sciences, University of Alaska Fairbanks: *"*Impact of unregulated ship emissions on air and water quality in southern Alaska"

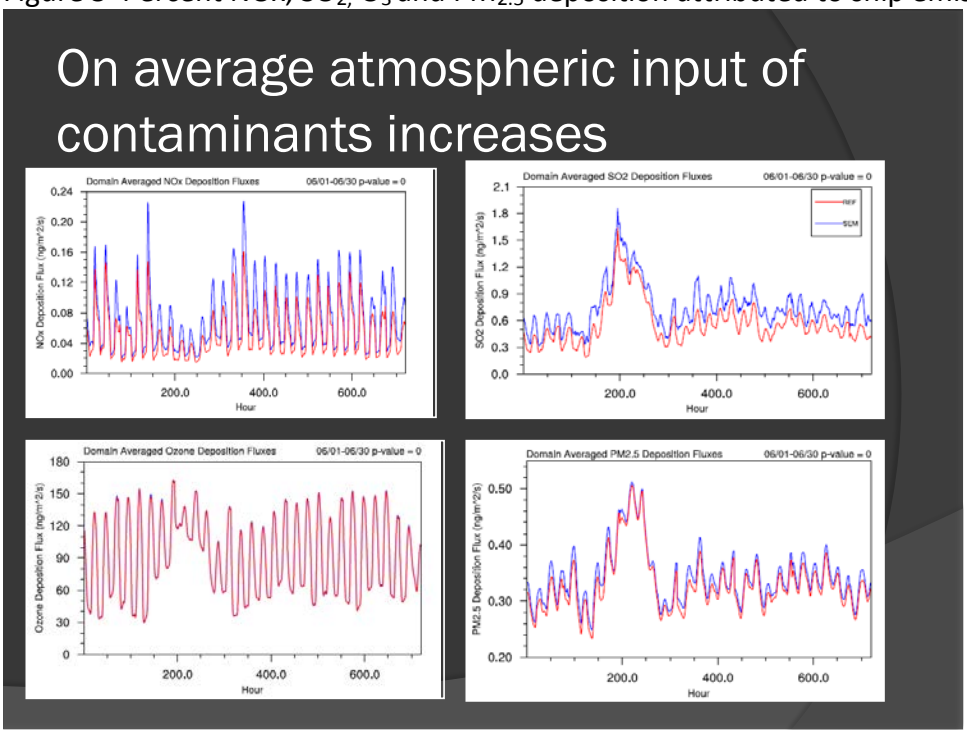
Nicole Mölders reported results from a study of shipping emissions related to major ship routes through Prince William Sound (PWS) and Cook Inlet, and around Kodiak (Figure 5). Ship emissions increase atmospheric input of NOx and SO_2 in PWS by up to 90%. Inland, Kenai Fjords National Park sees 20-30% of deposition due to ships, and coastal regions of Lake Clark National Park and Preserve greater than 10%

Primary and secondary aerosols ($PM_{2.5}$, PM_{10}) are also significantly increased due to ship emissions (90% of these aerosols are $PM_{2.5)}$. Ship emissions are also the greatest contributors to the deposition of particulate matter in PWS and other port cities. Meteorological factors such as wind speed, temperature, and precipitation strongly affect transport, transformation, and deposition of particulate matter. Overall, ship emissions: significantly increase the average concentrations of both primary and secondary pollutants over the shipping season; significantly affect air quality in Lake Clark National Park and Preserve, Kenai Fjords National Park, PWS, and port cities; affect air quality landwards in the regions with dominant wind directions; are responsible for notable deposition of NO_x, SO_2, $PM_{2.5}$, and PM_{10} in National Parks; and, severely reduce visibility within Prince William Sound.

Mölders and her colleagues also examined how international shipping from Asia might affect these same parameters. Observations at various IMPROVE (Interagency Monitoring of Protected Visual Environments) sites in Alaska that are close to the ocean showed slight increases in aerosol concentrations despite no anthropogenic sources nearby. Their study, conducted for January 2000, led to the following conclusions: advection of pollutants from ship emissions contributes temporally to SO_2, SO_4^{2-} and may explain the increases at IMPROVE sites; aged polluted air from Asia and international ship lanes reaches Alaska; the altered chemical

composition of the atmosphere leads to changes in gas-to-particle conversion, chemical reactions, and atmospheric input into ecosystems; temporally enhanced ozone advection/formation occurs along the Alaska panhandle due to increased ship emissions. This situation and what happens to ship emissions, differs from what is known to occur in mid-latitudes. Control of ship emissions is thus important to mitigate air pollution.

Figure 5 Percent NOx, SO_2, O_3 and $PM_{2.5}$ deposition attributed to ship emissions

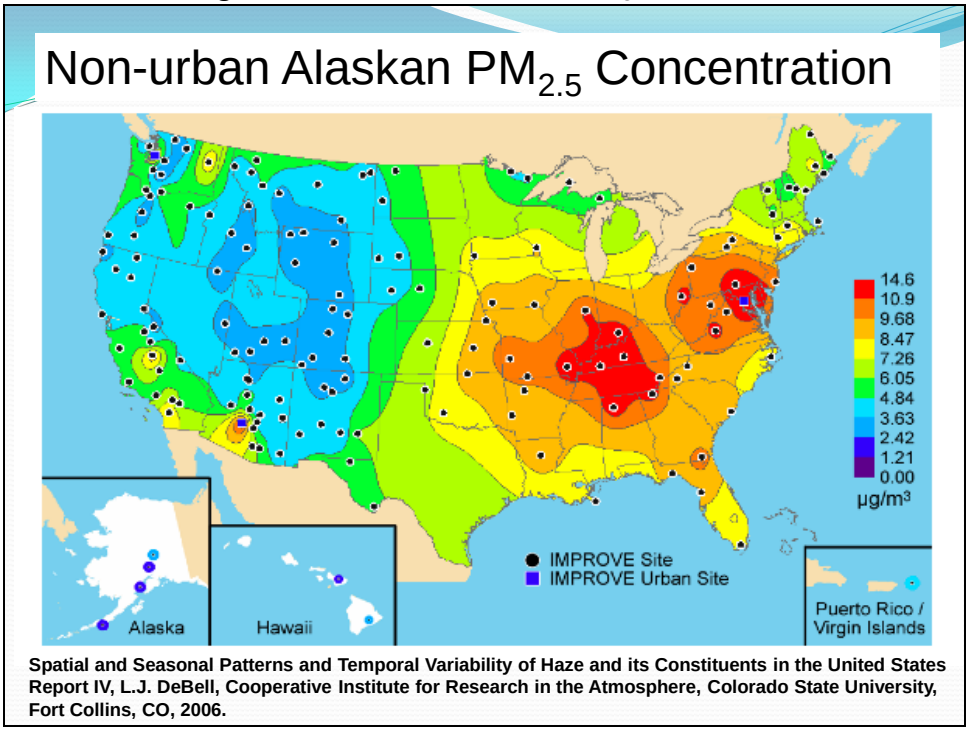


Cathy Cahill, Associate Professor, Geophysical Institute and Department of Chemistry University of Alaska Fairbanks: "Transboundary Atmospheric Transport: Local vs. Long-Range Air Pollutant Transport".

Cathy Cahill began her presentation with some definitions (atmospheric aerosols, particulate matter) and some of the basic impacts of aerosols on health, visibility, nutrient and pollutant deposition and climate. Because aerosol levels in Alaska and Northern Canada tend to be low (Figures 6 and 7), small increases are often observed visually.

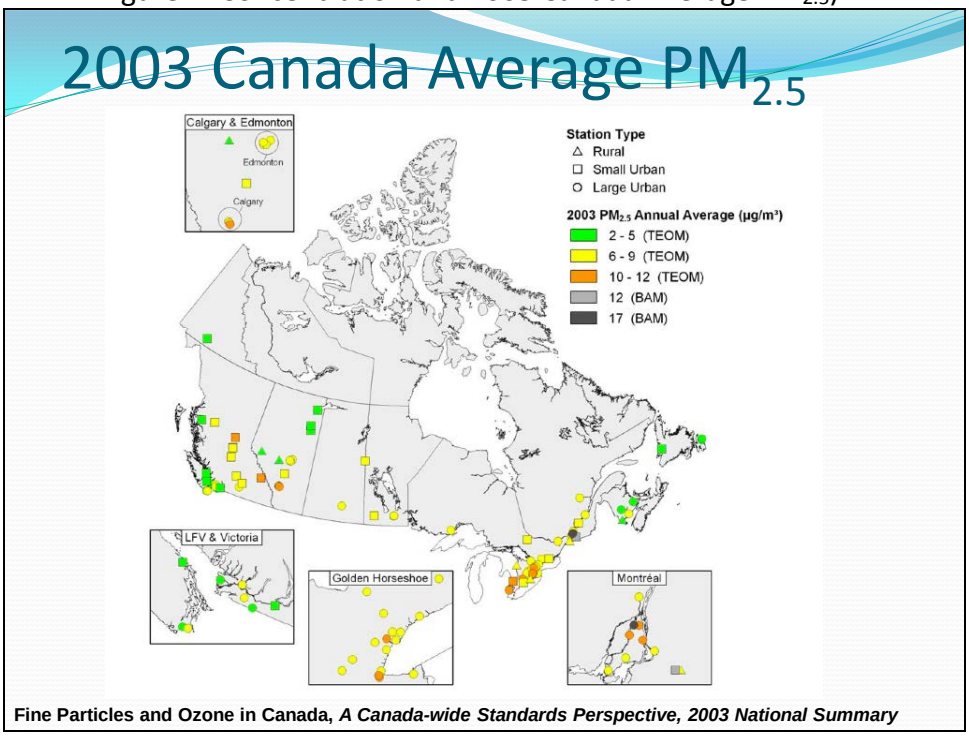
Climate change, global industrialization and local population growth in the northern centres will all contribute to greater deposition of aerosols. It is a complex task to evaluate sources of northern aerosols (local contribution vs. long-range contribution) and how best to manage these sources. Cathy Cahill went on to describe several natural sources (e.g., wildfires, oceanic aerosols, volcanic aerosols, desert dust storms, etc.) and local sources (mining, smelting and power plants, wood stove and internal combustion engines during inversions, etc.).

Figure 6 Non-urban Alaskan $PM_{2.5}$



Spatial and Seasonal Patterns and Temporal Variability of Haze and its Constituents in the United States Report IV, L.J. DeBell, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, CO, 2006.

Figure 7: Concentration and 2003 Canada Average $PM_{2.5}$)



Fine Particles and Ozone in Canada, *A Canada-wide Standards Perspective, 2003 National Summary*

Cathy Cahill concluded that aerosols from local and distant sources impact air quality in northern regions of the U.S. and Canada; the trans-boundary nature of the aerosols means that international cooperation will be required to reduce the quantities of those aerosols; and that decreasing aerosols from local sources will require local regulatory action. Related to the last conclusion on local sources, she indicated the importance of identifying the impact of each $PM_{2.5}$ source and going after the 'most bang for the buck' sources first, using common sense solutions, evaluating what other states/countries have done (e.g., adding rules limiting the use of boilers and noncertified woodstoves), switching heating sources to natural gas and newer less polluting technologies such as coal to liquid technology, etc.

2.2 DAY 2 (August 18)

2.2.1 Session III: Human Health and Air Quality in the North

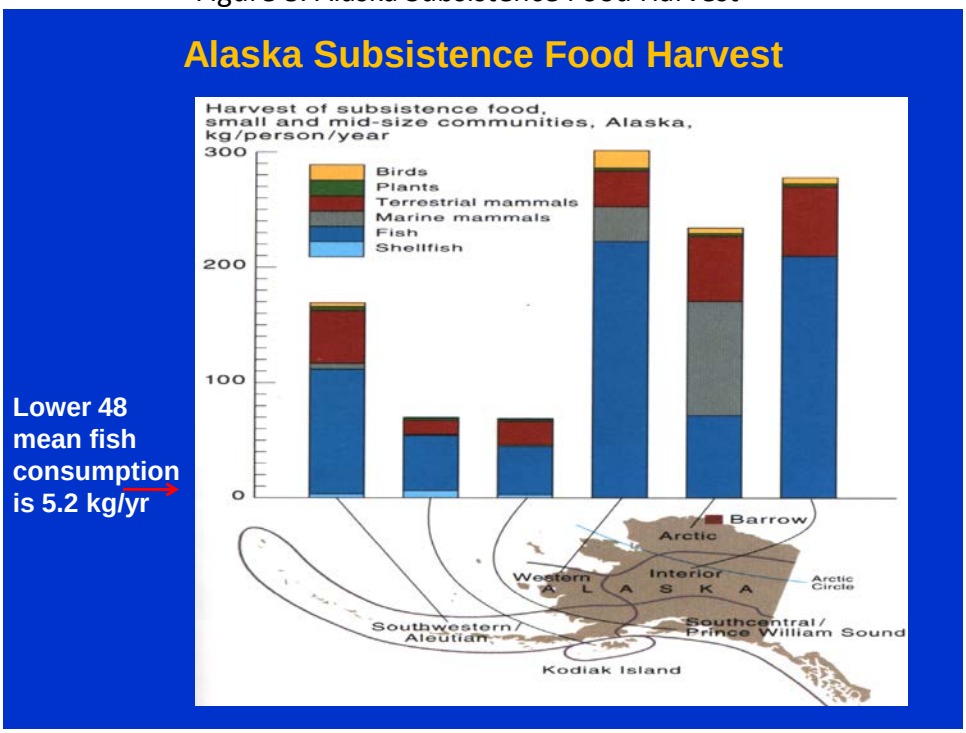
Kathy Tonnessen, US IAQAB member and Research Coordinator with the National Park Service, facilitated Session III. Contaminant loadings to the environment have a different impact in this region because they affect regional fish and wildlife, an important local source of food, especially for native people. Public health professionals encourage harvesting and consumption of local fish and mammals, since the health benefits of country foods often outweigh the risks posed by exposure to contaminants. Discussion at this session focused on the continued vigilance needed to ensure appropriate monitoring networks are in place, not only for air quality monitoring but also for contaminants in fish tissues and other native foods.

Lori Verbrugge, Environmental Public Health Program Manager, Department of Health and Social Services, State of Alaska (now with the US Fish and Wildlife Service, Anchorage, Alaska): "Update on human biomonitoring projects to assess mercury exposure in Alaska"

Subsistence foods are a major dietary component for many Alaskans (Figure 8), especially in rural areas, where consumption is self-reported to be as high as 300 kilograms/person/year. Seafood (fish and shellfish) makes up the majority of the subsistence diet in all areas of Alaska except the northernmost Arctic region. In addition, recreational fishing results in consumption of species known to be contaminated by mercury as well. Concern over exposure to pollutants in traditional foods (especially fatty species of fish and marine mammals) has led to consideration of consumption restrictions by health experts. Lori Verbrugge indicated early in her talk that there are significant drawbacks to such restrictions, including: health risks associated with alternative foods (i.e., increased saturated fat and carbohydrates can lead to heart disease and diabetes respectively); loss of nutritional and health benefits (i.e., omega-3 fatty acids, protein and fat based caloric sources, minerals, vitamins, etc.); overall negative health impact of dietary and lifestyle changes; the high cost of replacement foods; and, social, economic and health consequences from the breakdown of subsistence practices. The highest

mercury levels in Alaskan fish occur in large lingcod, salmon shark, spiny dogfish, yelloweye rockfish and large halibut. Women of childbearing age and young children are most sensitive to the harmful effects of mercury exposure.

Figure 8. Alaska Subsistence Food Harvest

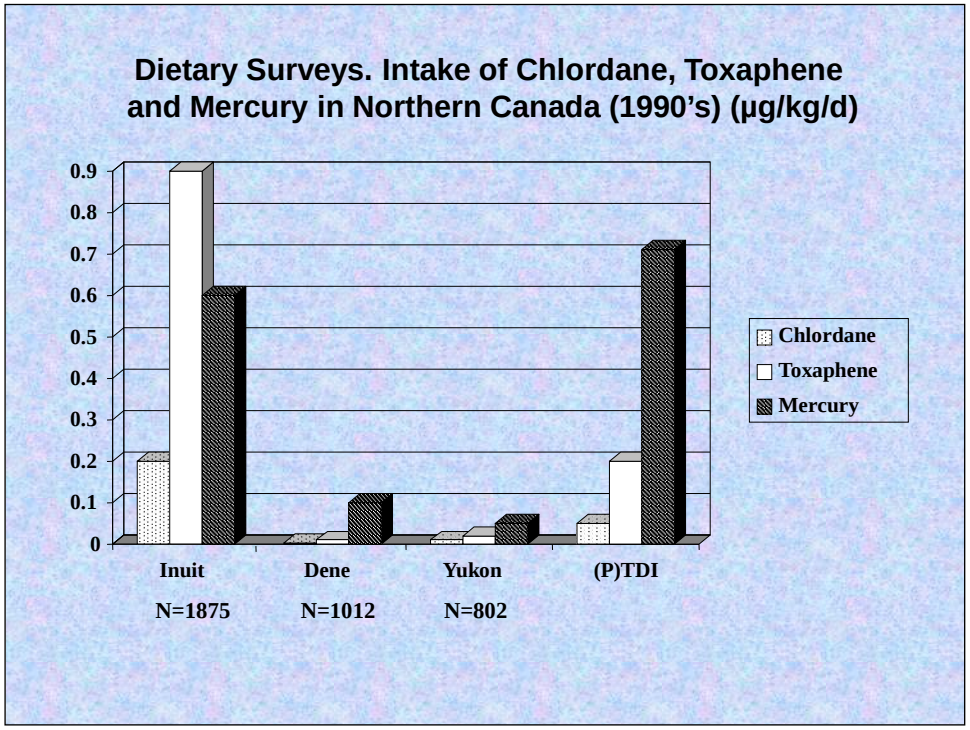


Alaska-based fish consumption advice related to mercury was issued in 2007 and took into account biomonitoring data for the Alaskan population (mostly mercury levels as measured in hair) and fish (mostly marine species and freshwater pike muscle mercury levels). The consumption guidance was less restrictive than many other states in the US due to risk-benefit considerations and there was an understanding that the guidelines were subject to change as more data became available. Lori Verbrugge concluded with the following thoughts: many Alaskans rely on fish as a healthy dietary staple and fish consumption levels are high; Alaskan fish species vary widely in their mercury content, with many species such as wild salmon having very low mercury levels; some regional dietary differences are reflected in hair mercury levels in Alaska; targeted monitoring projects like the US Fish and Wildlife Service pike monitoring and the US Department of Health and Human Services hair monitoring partnership provide communities with tailored dietary advice; and action is warranted to ensure the safety of Alaska's food supply because of its unique nutritional, cultural, and economic importance.

Jay Van Oostdam, Senior Epidemiological Advisor, Chemicals Surveillance Bureau, Healthy Environments and Consumer Safety Branch, Health Canada: "Human Health Implications of Environmental Contaminants in Arctic Canada"

Jay Van Oostdam provided information on multi-agency studies which evaluated levels and occasionally effects of contaminants such as persistent organic pollutants (POPs) and metals in cord blood and maternal blood of northerners in NWT, Nunavut and Nunavik. Among northerners, Inuit participants had the highest exposure (intake) of mercury, chlordane and toxaphene compared to Dene and Metis participants (Figure 9). Blood concentrations of PCB and mercury were very low in the Inuvik Region of the NWT, and approximately a quarter of the same values in Baffin Region (Nunavut) and in Nunavik for the same period. Concentrations of all these substances have decreased since the measurements made in the 1990s. While most of the differences between regions in exposure and blood levels can be explained by the types and amounts of traditional foods consumed (marine species of fish and mammals vs. fresh water fish and land mammals), the declines over time likely indicate that global, regional and national controls are slowly reducing deposition of several contaminants in the Arctic and/or that diets are changing.

Figure 9. Dietary Surveys, Intakes of Chlordane, Toxaphene and Mercury in Northern Canada



Traditional foods have very significant nutritional, social, cultural and spiritual values for Indigenous People. Yet social, economic and cultural pressures from the south are altering diets and socio-cultural practices for many Inuit, especially the younger generation. Food security has

become an issue (availability of traditional food species, knowledge of how to hunt, safety on the ice with changing climates, etc.). And there remains concern about the safety of traditional foods (adverse health effects of contaminants, animal disease, etc.) vs. the benefits of these same foods. Dietary transitions are taking place in the arctic and indicate an increase in consumption of store-bought foods which are high in carbohydrates and low in beneficial fatty acids. Territorial health agencies encourage the continued consumption of traditional foods due to their positive contribution to health.

Eva Kruemmel, Senior Health Research Officer, Inuit Circumpolar Council: "International Agreements on Global Contaminants and Implications for Inuit Health"

Eva Kruemmel provided a background for global action on POPs from the perspective of the Inuit Circumpolar Conference (ICC). The ICC represents over 155,000 Inuit across the Arctic (in Alaska, Canada, Greenland, and Chukotka). The ICC is a permanent participant of the Arctic Council and contributes to assessment reports of the Arctic Monitoring and Assessment Program (8 Arctic States), the Northern Contaminants Program (Canada), and discussions at international fora that consider controls on POPs and metals e. g., the United Nations Economic Commission for Europe's Convention on Long Range Transport of Airborne Pollutants (UNECE-LRTAP) Protocols, the Stockholm Convention, the Global Agreement on Mercury negotiations, etc.). Eva Kruemmel described the nature and processes of the Stockholm Convention on POPs and the state of the negotiations of the global agreement on mercury. While the ICC has been influential in the development of both international tools, non-governmental organizations (NGOs) generally are only acknowledged as observers at UN meetings (although Canada regularly includes NGOs in its delegation). She emphasized the high priority that must be given to a larger voice for Inuit and for valuing human/environmental health vs. economics alone. With respect to long-range transported environmental chemicals, Inuit are among the most exposed/affected people of the world due to their traditional diet and need to be more included in discussions and the decision making that affects their future. Global agreements are essential for protecting minority groups and partnerships between the ICC and some national governments and international organizations are a positive model for others to follow.

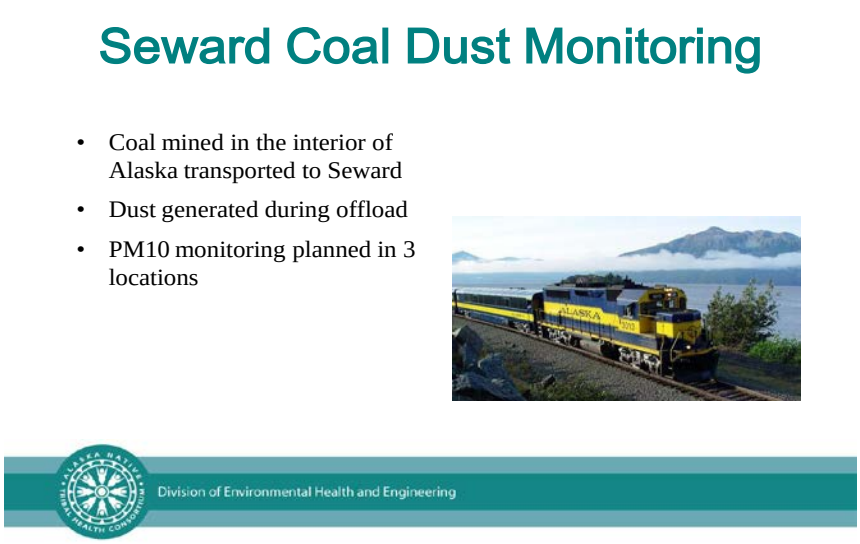
Troy Ritter, Senior Environmental Health Consultant, Alaska Native Tribal Health Consortium: "An Overview of Air Quality Issues of Interest to Alaskan Native Peoples"

Troy Ritter works for the Alaska Native Tribal Health Consortium, the largest tribe-managed health organization in North America (229 Tribes). The strategic priorities of the Environmental Health Services (EHS) group within the Consortium have been focused on water quality and waste water management, solid waste management, disease vector control and injury prevention. Recently, the EHS has initiated activities to examine air quality because of concern over the high burden of respiratory disease, and based on input from health care providers and Tribe members. With funding from USEPA in 2008, a needs assessment indicated five priority areas: road dust, indoor air quality, resource development, diesel generators, and open burning of solid waste (Figure 10).

Figure 10: open burning

The EHS undertook several projects to dig deeper into issues of concern. Volatile organic compounds were detected in a home near an old World War II military site and remediated through ventilation of the home. Concern over aerosol releases from North America's largest oil reserve near Nuiqsut, Alaska led to an audit of the industry data, sampling for volatile organics and a comprehensive air pollution assessment. These results were communicated directly to tribal members. In the future, the EHS will monitor particulates from the off-loading of coal near Seward (Figure 11).

Figure 11: Seward coal train



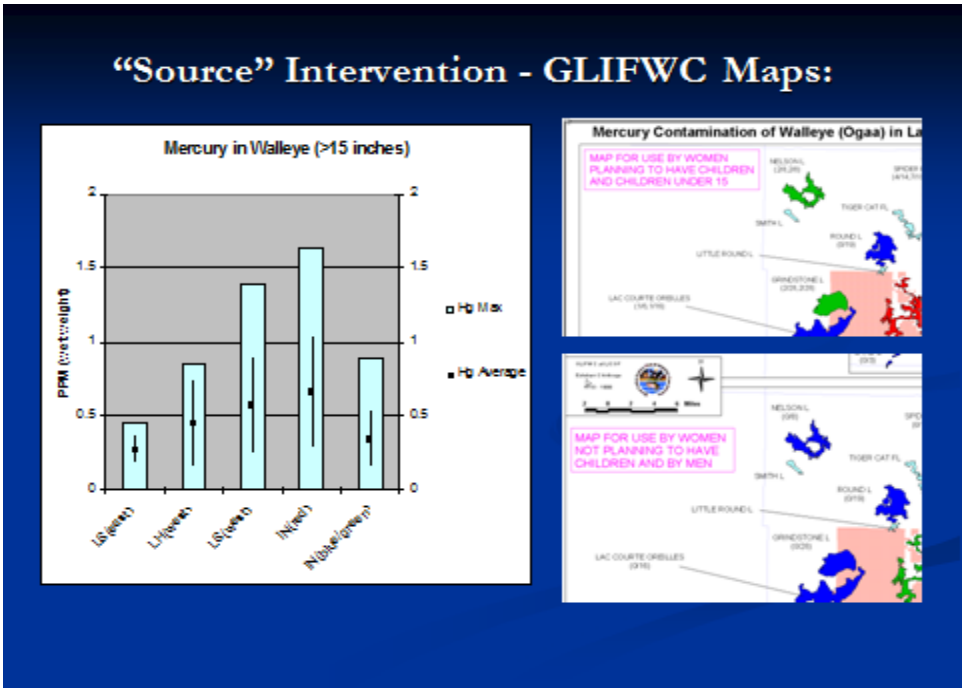
As part of a continuing effort to develop tribal capacity in air quality issues, several village coordinators have been trained and are working with students at village schools to conduct monitoring for home aerosol concentrations Troy Ritter expressed the hope that these efforts will lead to a State-wide inventory of air quality issues (village by village) and ultimately a State-wide air quality plan.

John Dellinger, US co-chair, Health Professionals Task Force and University of Wisconsin, Health Sciences: "Risks and Benefits of Consuming Great Lakes Fish"

John Dellinger identified an ongoing public concern about fish consumption and fish advisories. While fish are widely accepted as a 'healthy' food, there is considerable confusion among consumers over the conflicting opinions regarding consumption. There is a need for 'effective translational research' to help explain the complex issues faced by researchers and the community. Dellinger reported on the extensive sampling results (Figure 12) from the Great Lakes Basin undertaken by tribal partners through the Inter-Tribal Fisheries and Assessment Program. He also provided an analysis of the biological residue and self-reported health problems data base for the Ojibwe Health Study.

Fish advisories and how they are communicated vary greatly. John Dellinger described one ancient and three recent examples of how fish consumption messages can be simplified. One recent approach by the Great Lakes Indian Fish and Wildlife Commission uses source intervention maps which can be interpreted by readers.

Figure 12. "Source" intervention-GLIFWC maps



Another, developed through the Urban Hmong Milwaukee, uses bilingual, culturally relevant materials (video, interviews with scientists and community leaders, tackle box cards and pre/post evaluations to information transfer). Another intervention strategy (e.g. Figure 13)developed by the Anishnabe uses culturally relevant information, involves the community in the development of the information (brochures, posters, DVDs) and accesses traditional knowledge.

Figure 13. Promotional Poster.

Advice provided in most of these initiatives relates to size, source and species of fish, how to trim, fillet and cook fish to reduce contaminant exposures and information on nutritional benefits. Many fresh water fish species have healthful concentrations of omega-3 and omega-6 fatty acids, which are known to promote good heart health. Follow-up evaluations of the effectiveness of guidance materials are essential.

2.2.2 Session IV: Air Quality Monitoring and Air Modeling Studies of Air Contaminants

Harold Garabedian, US IAQAB member with the State of Vermont, facilitated Session IV. Monitoring networks and observational data are fundamental to acquiring the transboundary data required to understand the air pathway of pollutants that transport contaminants to the freshwaters in the North. This session explored how Canada and the US, by working together, could fulfill their international commitments to monitoring contaminants in fish and other aquatic organisms in the North.

Dave Schirokauer, Biologist, Natural Resources Program, Manager Klondike Gold Rush NHP, National Park Service: "Federal efforts at remote air quality monitoring sites within the State of Alaska"

Dave Schirokauer provided extensive information about air and biota monitoring initiatives conducted by the US National Park Service, the USDA Forest Service, the US Fish and Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration (NOAA) in Alaska. The three class 1 airsheds in the state (Denali, Tuxedni, and Simeonof Wilderness Areas) have associated IMPROVE (Interagency Monitoring of Protected Visual Environments) sites and long-term, lichen- and moss-based bio-monitoring programs. In addition, Denali National Park and Preserve hosts NADP (National Atmospheric Deposition Program), CastNet (Clean Air Status and Trends Network), and NPS Ozone stations at park headquarters on the north side of the Alaska Range and IMPROVE and CastNet stations at Trapper Creek on the south side of the Alaska Range. Denali's NADP site has been operating since 1980 and is the longest continuously running station in Alaska. Lichen tissue collections and community plots are used extensively to monitor atmospheric deposition of heavy metals, nitrogen, and sulfur contaminants in the Tongass National Forest. Wet deposition of mercury is monitored in Glacier Bay and Gates of the Arctic National Parks. Extensive seabird egg monitoring for POPs and Hg (Gulls, Murres and Kittiwakes) conducted by the USFWS, coupled with the capacity for cryogenic storage, enables current monitoring and the potential for future retrospective monitoring information. Mussels are also monitored in Alaska under the NOAA Mussel Watch program. Three Southeast Alaska National Parks (Glacier Bay National Park and Preserve, Klondike Gold Rush National Historic Park, and Sitka National Historical Park) have also developed a monitoring system using lichens and passive sensors to evaluate impacts on these ecosystems from local sources, shipping and long-range Eurasian smelters and coal fired generators. Data from 1998-2008 indicate there is significant change in deposition chemistry in some areas of Southeast Alaska.

Barbara Trost, Air Monitoring Program Manager, Department of Environmental Conservation, Government of Alaska: "Status of the State of Alaska's Air Quality Monitoring Efforts"

Barbara Trost provided some demographic information for Alaska, similar to the information on the Canadian north provided by Dave Fox on Day 1. Alaska has a total population of approximately 670,000; almost half of this population lives in or near Anchorage. One-third of the population lives in communities of less than 3000 and average village size is between 300-500. There are 229 tribes in Alaska. Oil is the biggest revenue source in the State and 40% of all employed individuals work for Federal or State government.

> Trost then described air quality standards in Alaska, some of which have changed, placing some areas/communities out of compliance. Carbon monoxide levels are now very low compared to historic levels and exceedances are negligible (cleaner cars).

Figure 14: Natural sources of PM10

Figure 15: Anthropogenic sources of PM10

PM_{10} exceedances associated with natural events (windblown dust, volcanic eruptions and pollen) are also very low, although exceedances are observed during periods of extensive forest fires. PM_{10} levels have declined in large centers primarily due to road paving.

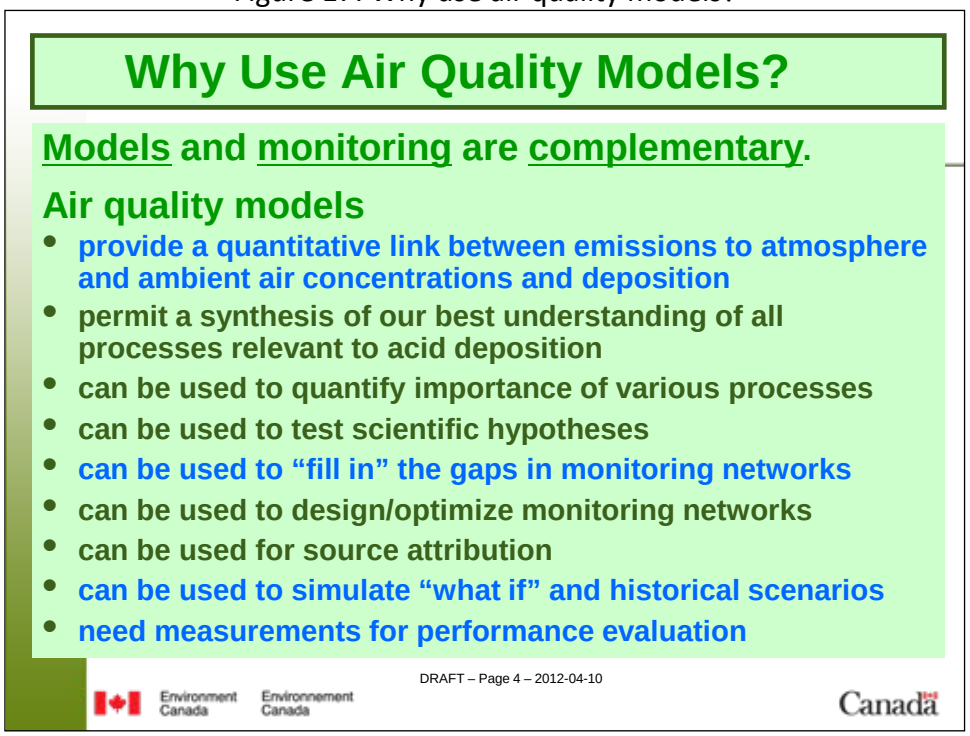
Figure 16: Forest Fires

As in the Yukon, geography and very cold weather can also lead to inversions and to exceedances in some regions of Alaska (e.g., Fairbanks). The source mix is complex; however, space heating with low cost fuels (wood and coal) is a significant contributor during periods of inversion. Barbara Trost provided some detailed figures related to the source mix in Fairbanks and indicated that the current $PM_{2.5}$ standard may be made more protective (lowered). She concluded her presentation by mentioning their upcoming investigations of air quality in rural locations.

Michael Moran, Research Scientist, Air Quality Research Division, Environment Canada: "Recent Initiatives in Air Quality forecasting and policy-related modeling in Canada"

Michael Moran described the value of source-oriented air quality models for scientific predictions and policy development purposes. These models examine in three dimensions how meteorology, emissions, and atmospheric processes (transport, transformation and deposition) combine to affect air concentrations and loadings.

Figure 17: Why use air quality models?



Air quality models and monitoring are complementary. Environment Canada uses a number of numerical models for studying transboundary transport of pollutants from the urban to global scales, for short-term forecasting (ranging from storm surges and sea ice movement to volcanic ash, and from surface pollutant concentrations to upper-level ozone and solar radiation), and for simulating the impacts of potential control measures on photochemical smog, acid deposition and air toxics. The Global Environmental Multiscale (GEM) model is Environment Canada's operational numerical weather prediction model and can be scaled to run at the global level, the regional level, or a more limited (sub-regional) level. GEM is used to provide meteorological fields to air quality models.

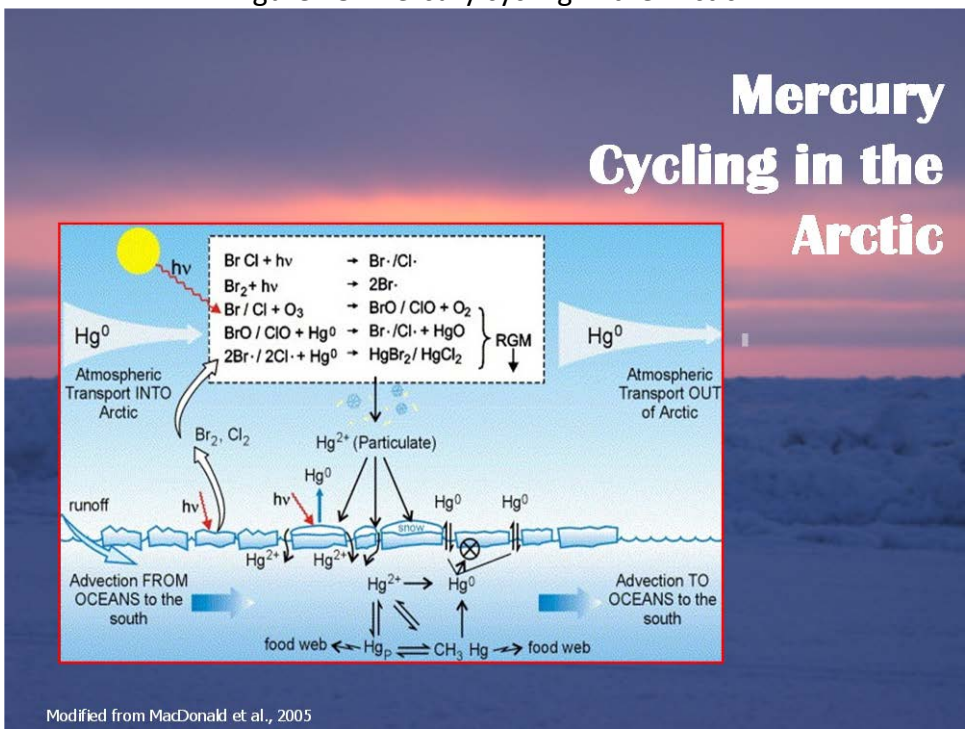
Air quality models in use by Environment Canada were provided (see below) along with extensive examples of predictions of regional-level deposition of $PM_{2.5}$, polychlorinated biphenyls (PCBs), some other POPS, and mercury.

- (retired: ALOM, ADOM, CHRONOS
- AURAMS A United Regional AQ Modelling System
- GEM-MACH GEM – Modelling Air quality and CHemistry
- GEM-BACH GEM with Belgian Air quality and CHemistry
- GRAHM Global/Regional Atmospheric Heavy Metals model
- MEDIA Multicompartment Environmental DIagnosis & Assessment
- CanMETOP Cdn Model for Environmental Transport of OC Pesticides
- GEM/POPS Global Environmental Multiscale model with POPs

Sandy Steffen, Physical Scientist and Atmospheric Mercury Specialist, Environment Canada: "Mercury Behaviour in an Arctic context"

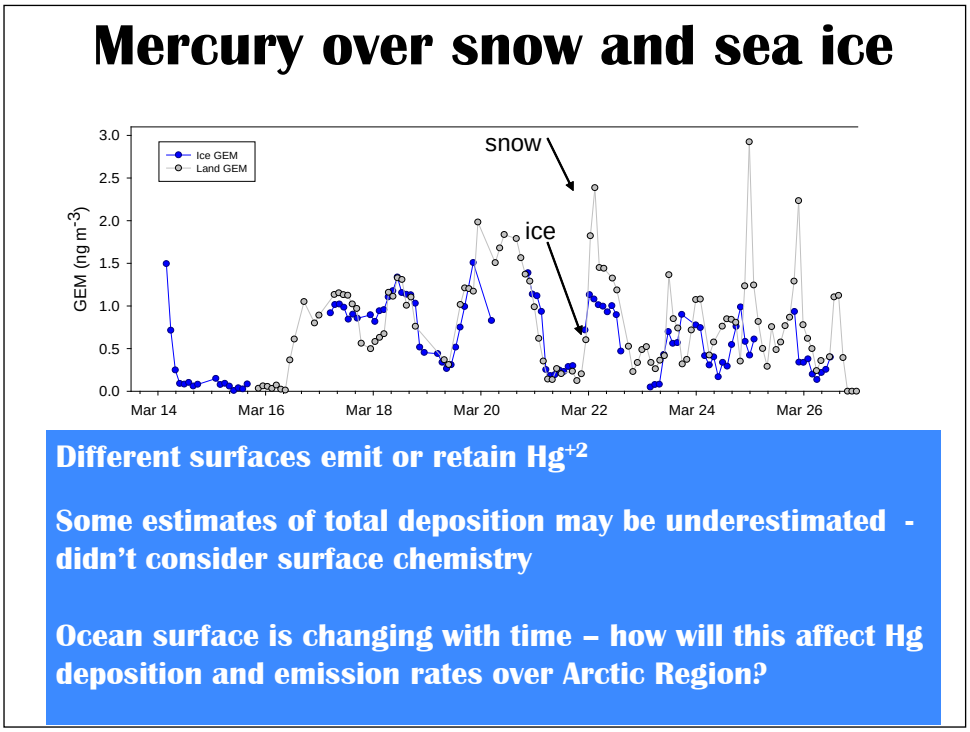
Sandy Steffen began by indicating the vulnerability of Arctic populations to mercury exposure and effects (neurological, psychological and cardiac effects) and vulnerability of the Arctic to significant inputs from external sources. Relatively new science has described how mercury cycles in the Arctic and why springtime sunrise is an important deposition event.

Figure 18. Mercury cycling in the Arctic



Sandy Steffen was part of the IPY INCATPA team and examined the transport of mercury from the pan-pacific into the Canadian Arctic, using source receptors on the ground and transport models to explain deposition. Using the GRAHM (see model list above), most mercury from Asia had low transport efficiency but caused most of the amount transported long-range into the Arctic (about 43% to 67%); whereas, mercury coming from Russia had a high transport efficiency but contributed less to overall loadings. To develop a more comprehensive picture, more measurements are needed and especially at the Yukon and Whistler BC site. In addition, data from US sites in Alaska would be valuable for identifying temporal and spatial trends. Climate change is also likely to be a significant factor in transport and deposition. For example, the cycling of mercury over snow pack, sea ice and open ocean (Figure 19) are different (although not well understood to date) and as the Arctic ice cap melts, we need to consider how this will affect deposition and emission rates over the Arctic Region.

Figure 19. Mercury over snow and sea ice

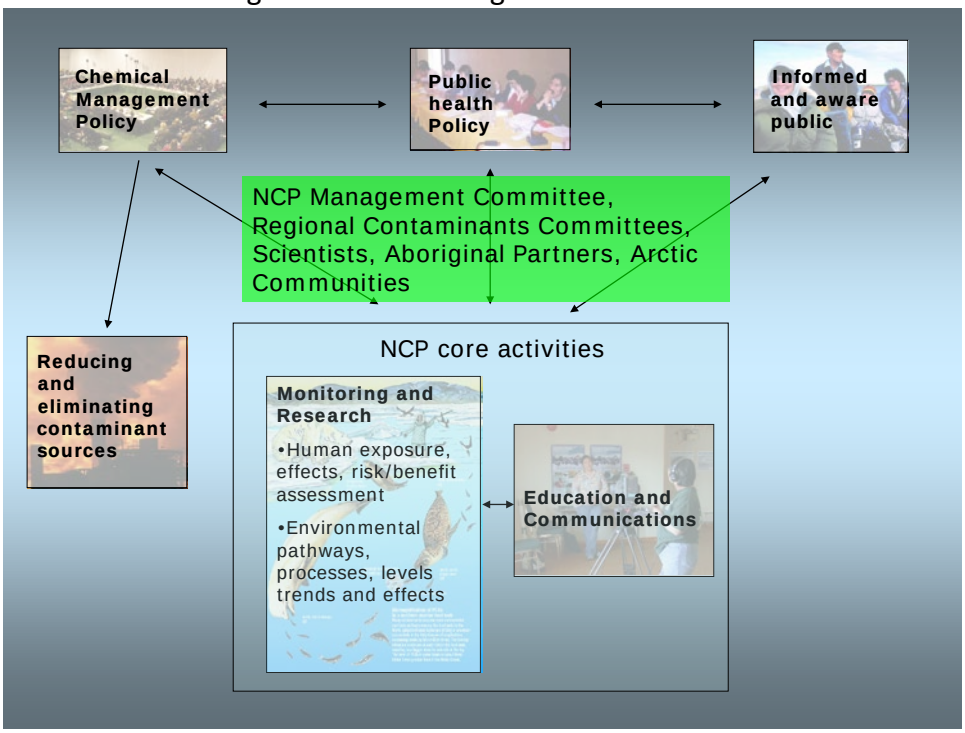


Jason Stow, Environmental Scientist, Indian and Northern Affairs Canada: "Current Activities of the Northern Contaminants Program (NCP) and Arctic Monitoring and Assessment Programme (AMAP) and how they relate to northern issues Air Modeling for Contaminants"

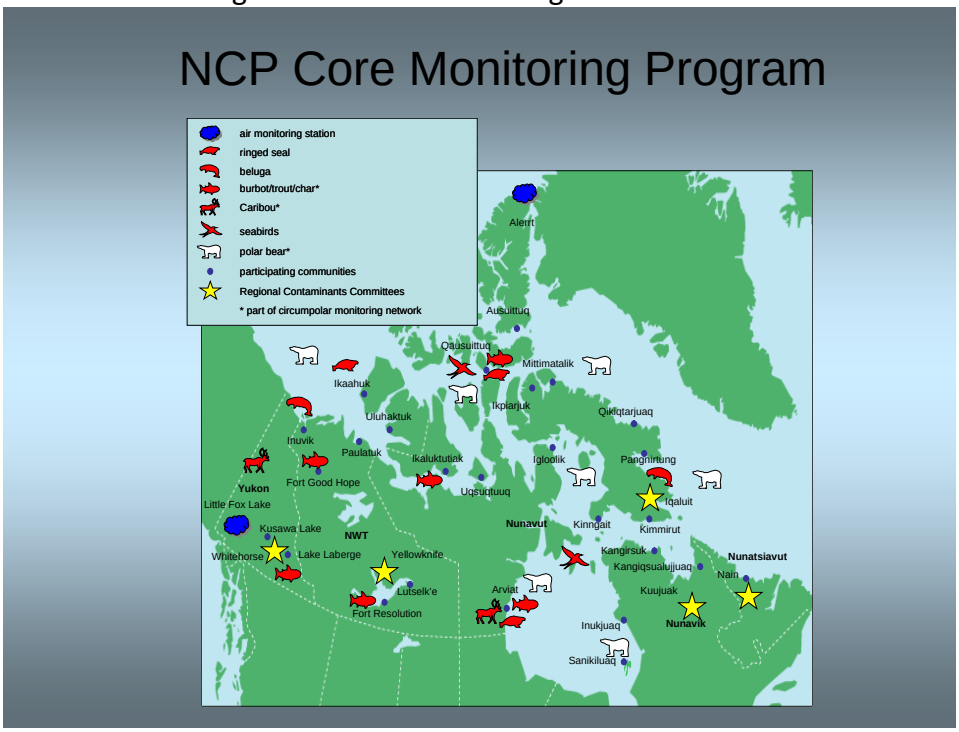
Jason Stow provided a description of the evolution of the circumpolar AMAP initiative under the Arctic Council of Ministers (8 states and 4 permanent participants) and the Canadian NCP (Figure 20). The NCP contributes its data and assessment work to the circumpolar initiative under the AMAP. The first assessments produced by the NCP and the AMAP (both in 1997) were pivotal in launching the negotiations for the UNECE Protocols on POPs and metals and the Stockholm Convention which entered into force in 2003 and 2004, respectively. The management model and 'core monitoring' activities for the NCP are shown in Figures 20 and 21.

Monitoring data reported by the NCP and the AMAP indicate some success in lowering levels of many legacy POPs over the last 20 years, probably as a result of national, regional and global controls (e.g., the average declines in Arctic biota have been 42% and the average declines in milk from Inuit mothers in Canada have been 62%). Levels of some fluorinated compounds related to perfluooctanylsulfate (PFOS) are increasing in some biota and remain elevated in mother's milk in some regions of the Arctic.

Figure 20: The management model for the NCP



*F*igure 21: 'core monitoring' activities for the NCP



Mercury levels have appeared to increase in Arctic biota about 40% over the same time period (but decreased in the European Arctic). In the Yukon itself, mercury levels have increased in Burbot and Trout from several locations, leading health officials to work with communities to produce culturally sensitive fish consumption advice. Jason Stow concluded his presentation with a list of recently released or upcoming assessment reports on POPs, metals and the Arctic.

Aileen Stevens, Air Quality Programs Coordinator, Department of Environment and Natural Resources, Government of the Northwest Territories: "Air Management in the undevolved Territories"

Aileen Stevens provided an overview of the regulatory regime in the Northwest Territories (NWT), where there were gaps in the management of air issues, and how the Government of the NWT operates within this framework in a co-operative mode. The NWT, like other territories, receives its mandate from the federal government and, for environmental issues specifically, under the NWT Environment Protection Act (EPA). Other agencies are also responsible for specific aspects of the environment, e.g., Land and Water Boards, the national Energy Board and various federal departments (such as INAC, EC, TC, and DFO). To make matters more complicated, various regions and areas are also regulated by land claim agreements, other federal and GNWT acts and federal agencies.

Figure 22 – NWT Power Generating Stations

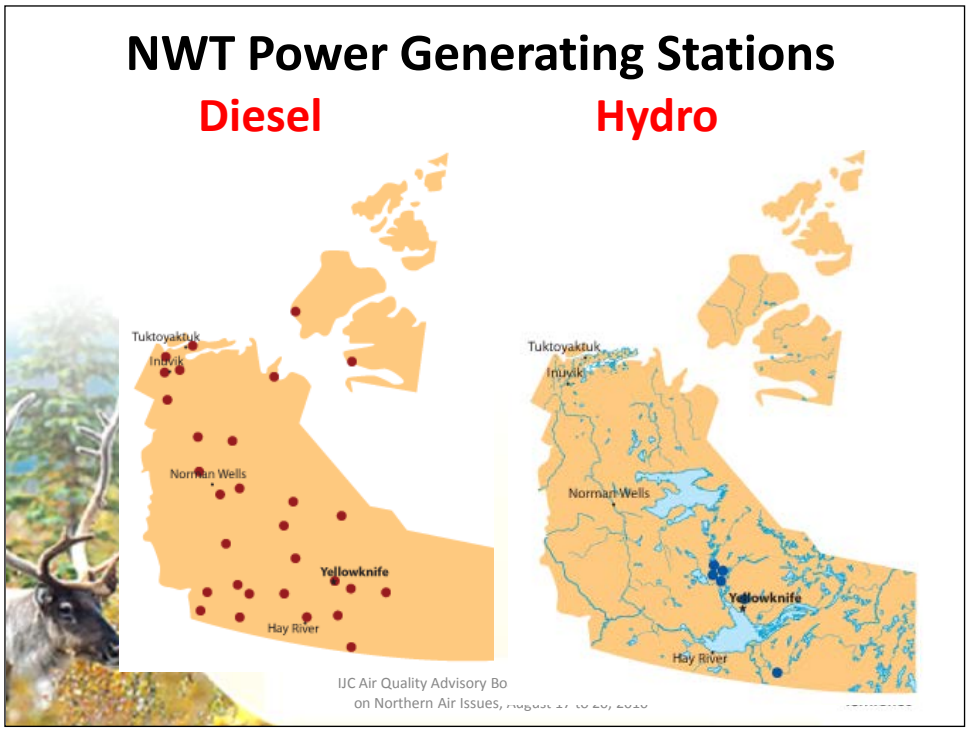


Figure 23 – NWT Mining Operations

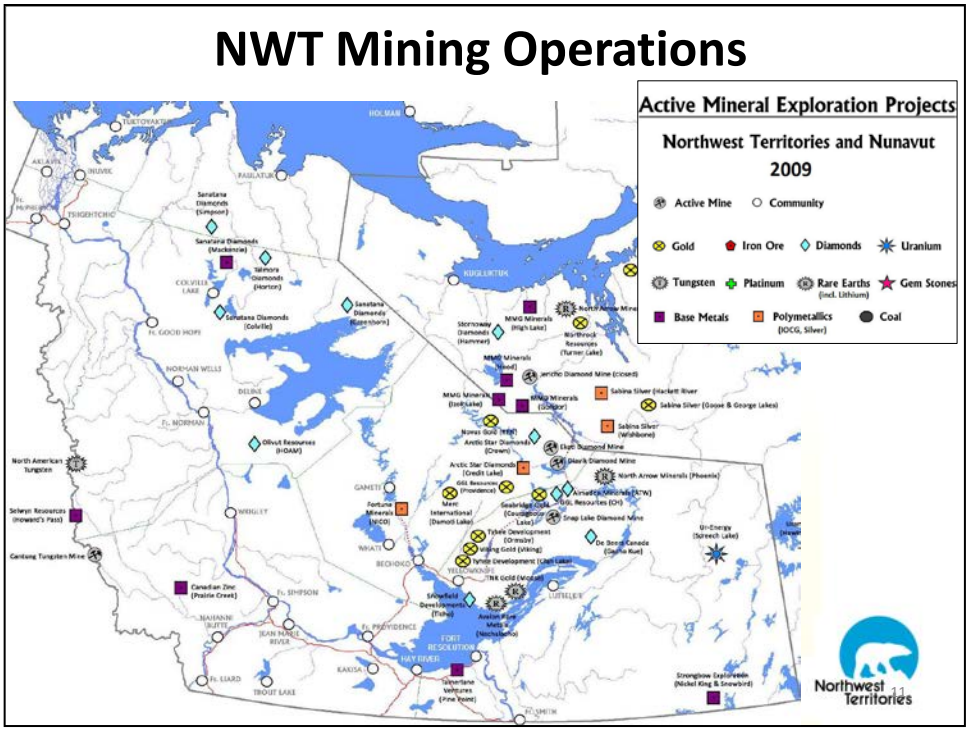
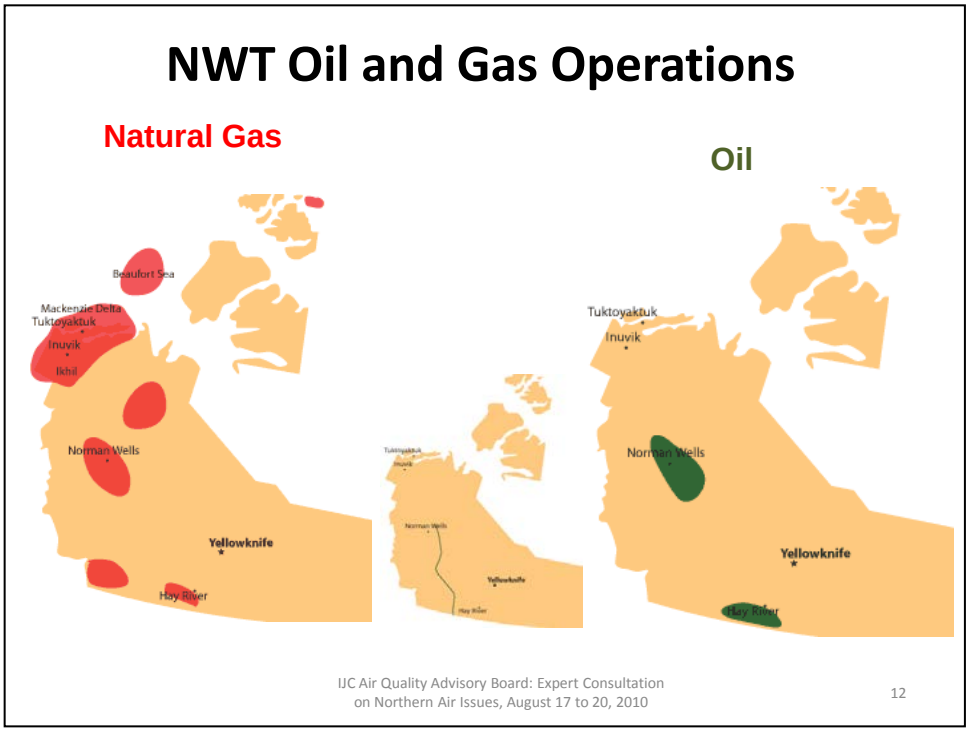


Figure 24 – Oil and Gas Operations



Aileen Stevens gave a description of NWT communities, power generation, mining and oil and gas sites and coastal traffic. The Environment and Natural Resources (ENR) Department works within the gaps to ensure an equivalent level of environmental protection across the NWT, to keep clean areas clean, and to prevent environmental liabilities for future generations. Most pertinent to discussion at this Session, the ENR operates an air quality monitoring network (4 continuous ambient monitoring stations, 2 NAPs stations, and an acid deposition CAPMoN station).

2.3 DAY 3 (August 19)

2.3.1. Session V: Bi-national Consultation

1. **Ann McMillan**, Canadian Co-Chair IAQAB and **Gary Foley**, US Co-Chair IAQAB, facilitated Session V.

The purpose of this consultation was:
1) delivery of a report to Commissioners; and
2) creation of a local network for continued dialogue regarding air quality issues.

In developing the report to Commissioners, the IAQAB expects that they will be interested in how transboundary air pollution across the Northern boundary compares with air pollution across the Southern boundary in terms of not only the science but also the state of policy around air quality management. Along the southern boundary, these aspects are driven by the Canada/US Air Quality Agreement, codifying the principle that the two countries are responsible for the effects of their air pollution upon one another.

The Canada-United States Air Quality Agreement has not yet been considered by governments in the context of the need to address transboundary air quality issues in the northwest part of North America along the northern border. The objective of this session was to discuss the utility of the Canada-United States Air Quality Agreement to address transboundary air quality issues, specifically, the transboundary region between Alaska and British Columbia/Yukon, and the potential role(s) for the IAQAB in supporting binational interactions along the northern border. To aid in facilitating this discussion, a white paper on the topic (*The Canada – U.S. Air Quality Agreement: Would it Provide a Basis for Co-operating on Air Quality in the North?*) was provided to participants.

The key points of the white paper are:

- The *Agreement between the Government of Canada and the Government of the United States of America on Air Quality (AQA)* is an international legal instrument that makes binding commitments between Canadian and U.S. federal governments to reduce their own emissions and provides a platform upon which the two governments can discuss and cooperate on common areas of concern (states/provinces/territories are not bound by AQA although they can/do participate in implementation).
- AQA was first negotiated in 1991 as a response to acid rain, then renegotiated to deal with ground-level ozone (2000) and is now under renegotiation to address transboundary particles (PM). The AQA has a main text and annexes on acid rain, ozone and scientific and technical cooperation. The acid rain and ozone annexes contain 'hard' commitments (that are legally binding) to reduce emissions of sulphur dioxide, nitrogen oxides and volatile organic compounds in order to reduce transboundary acid rain and ground-level ozone.
- Decision was made in 1996 that scope of the work under the AQA would not address transboundary toxic pollutants (other agreements were available regionally and internationally to cover toxics).
- The AQA has a 'soft' (non-binding) annex calling for the exchange of information and cooperation on scientific and technical activities and economic research (no specific financial resources are allocated). A lack of financial resources has acted as a barrier to cooperation when resources or interests have been insufficient on one side of the table or the other. The Air Quality Committee (AQC) is the decision-making and reporting arm of the Agreement (meets at least annually and reports to the governments of Canada and the USA biannually). The IJC and the IAQAB are not represented on the AQC. Membership from the US and Canada differs, e.g., provincial governments have always been members (B.C. and Alberta represent the western provinces and territories), whereas representatives of states are recent additions; the U.S. National Park Service (with responsibilities for air quality issues) has always been a member on the U.S. side of the AQC while Parks Canada (no responsibilities for air quality) has not. The AQC has two Sub-Committees.
- Canada and the United States have followed an established set of 'notification' procedures since 1994 to identify possible new sources of pollution and modifications to existing sources of transboundary air pollution within 62 miles (100 kilometres) of the border. However, notifications under the Agreement do not work well primarily because states and provinces/territories are not bound by the AQA commitments even though they have responsibility – especially in Canada - to permit new and significantly modified sources.
- 'Assessment' and 'Mitigation' parts of the AQA (Article V) are more successfully implemented. 'Consultations'(Article XI) became the basis for Guidelines prepared and approved by the Air Quality Committee in 1998 that laid out practical steps on how the two countries could consult informally when one country was concerned about a source of pollution in the other.
- The AQA (Annex I) contains a "hard" commitment on Prevention of Air Quality Deterioration and Visibility Protection that has been difficult for Canada to implement.

While preventing significant air quality deterioration and protecting visibility is part of the US *Clean Air Act*, in Canada, there are no goals for visibility and the ability to prevent significant air quality deterioration by governments is problematic (an issue that may be relevant to the North where the air quality is cleaner than national PM air quality standards). Canada is addressing its commitment through the 'continuous improvement' and 'keeping clean areas clean' principles of the Canada-Wide Standards (CWSs) for PM and ozone (non-mandatory standards). The CWSs are implemented differently by each province or territory and only BC is pursuing the issue of visibility.

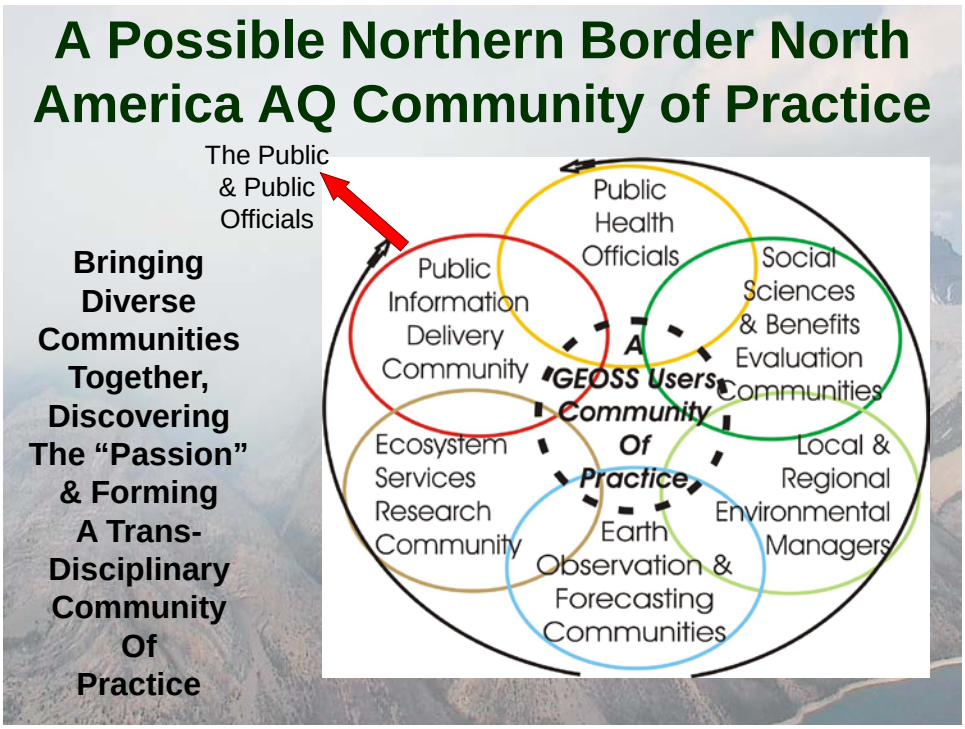
- Possibilities: The AQA contains provisions that could be a useful platform for northern transboundary air quality cooperation. For example, the Agreement's ability to provide a framework for bilateral cooperative discussion if a pollution source becomes a concern of one country or the other, and, the Agreement's commitments to address PSD and visibility. In a Yukon Territory – Alaska context, a process to notify the other party when a government is considering an operations permit for a large new industrial source whose pollution could cross the border might be helpful. Another example might be a binational science group with a mandate to do binational assessments in a northern setting.
- Difficulties: It is worth considering the extent to which the AQA fits northern issues as they are now identified. Toxic chemicals do not fit within the scope of the Agreement. If pollutants of concern in the North originate from countries outside the Canada-U.S. territory, the AQA is not a useful vehicle. Could northern governments convince federal jurisdictions to incorporate northern issues into the work of the Agreement? Do the AQC and the Subcommittees include the players important for collaboration in the North (they do not include Canadian First Nations and U.S. Tribes at the table) and effective cooperation on northern issues? Would the Air Quality Committee and Subcommittees be willing to bring in the right mix of representatives to meet the policy and scientific/technical needs of northern governments?
- Overall Outcome: If governments and the people who work in them want to cooperate to address a common concern, then it is possible to do much with very little. Several examples of co-operative agreements between provinces and states are described in the white paper. When people are willing, it isn't necessary to have an international agreement or a high-level cooperative arrangement to cooperate. It doesn't take much money or many resources to bring people together to talk, to exchange information and to learn from each other and, if there is a work plan to keep things moving and an agreed set of targets and timelines for the work, then it could be possible to develop solutions to common concerns.

As further background for the discussion, the co-chairs noted that a theme arising from the discussions emphasizes the Northern boundary region as a relatively undeveloped region being impacted by air pollution not only locally and regionally but internationally as well. In order to provide some further context, the co-chairs briefed the attendees on a couple of international initiatives with strong monitoring components that might be particularly significant in the North.

Gary Foley, US co-Chair IAQAB, Environmental Protection Agency: "The Global Earth Observation System of Systems (GEOSS)"

In the United States, the Global Earth Observation System of Systems (GEOSS) lead agency for user engagement is the Environmental Protection Agency, see website at http://www.epa.gov/geoss/. The purpose of GEOSS is to organize the world community to share environmental observation and monitoring data to allow for better decision making to enhance societal benefits, based on knowledge of environmental trends, globally. Under user engagement, GEOSS is addressing the spectrum of users, including researchers and earth system data service providers as well as environmental application developers and policy and decision makers to determine what sort of data is needed from the observational systems. Thus, GEOSS is actively gathering the information and data needs, user applications, user objectives, etc., from groups such as those at this Consultation. The GEOSS work plan spans 2007-2011, and one of its work plan tasks addresses the International Polar Year. Nations working with the International Polar Year (IPY) are using GEOSS to enhance the utilization of Earth observations in all appropriate realms (including, but not limited to, sea and land ice, permafrost, coastal erosion, physical and chemical polar ocean changes, marine and terrestrial ecosystem change, biodiversity monitoring and impacts of increased resource exploitation and marine transport). Since there are about a dozen successful Communities of Practice in GEOSS, Gary concluded his remarks by asking if the participants had an interest to develop a 'community of practice' for northern border North America Air Quality.

Figure 25: community of practice



Ann McMillan, Canadian co-Chair IAQAB, Environment Canada: "SAON- Updates on International linkages"

SAON (Sustaining Arctic Observing Networks) was initiated in 2006 as part of the International Polar Year (IPY). News from SAON can be found at the web site http://www.arcticobserving.org/. Three workshops were conducted during the IPY to address a number of Arctic science topics, and there are recommendations that were approved by the Arctic Council regarding monitoring of variables of importance to Arctic countries. SAON has achieved some early successes: all eight Arctic states have provided an inventory of National Observing Networks (for an example from Canada and the USA, see Figure 29. Atmospheric Monitoring in Northern North America);

Figure 26. Atmospheric Monitoring in Northern North America

SAON and the IPY data Management Committee held a joint workshop in 2010 (Oslo) to facilitate data access, archive and sharing through 'interoperability of observing and data management systems' and through early development of 'union catalogs' of data sets; early discussion of community-based monitoring with the Inuit Circumpolar Conference to include traditional knowledge and map-based registries; and a meeting on funding/governance in 2010 (Miami) with views and support from many of the funding and implementing organizations. SAON appears to be well on its way to continuing to be encouraged by the Arctic Council as an

IPY legacy but questions of ongoing support have yet to be resolved. In Canada the lead is Helen Joseph of the Department of Fisheries and Oceans Canada.

Session V Discussion:

After the co-Chairs had briefly discussed the two international monitoring activities (GEOSS and SAON) that could be linked to future work, they opened the floor for discussion framed by the question: *Do you need another organization?* The following key points arose:

- There is value in the having a trans-boundary organization engaged that is responsive to international problems e.g., long-range deposition. The challenge is that issues are often essentially regulatory in nature and thus get dismissed because they are in the sparsely populated "pristine" North. The weight of a trans-boundary organization could bring attention to Northern border issues, including international problems such as long-range atmospheric transport and deposition of contaminants.

- Major initiatives in the past like the IPY helped link the region to several important initiatives and this provided the impetus for analysing some of the data from the International Geophysical Year, which in itself initiated some very important programs.

  While the IPY was somewhat effective at data collection, there was no clear plan as to what to do with the data, and there was no money associated with it. Putting metadata together is ambitious and one needs to have the infrastructure. The execution of these matters is challenging. The IJC can help by getting the two nations to recognize that the infrastructure needs to exist so that individuals who have the will and want to make this work better can use it.

- A more comprehensive, inclusive approach to transboundary air issues is desirable and warranted. The IJC's Air Board is currently looking at a set of specific issues which is a good start, but is not looking at a broad and comprehensive suite of issues. The IJC should be helping ensure that these systems work and there should be an emphasis on avoidance of major peaks (spikes in air contaminants), which have the potential to do real damage. Major events should be of concern from volcanoes, fire fighting, Chernobyl cloud.

- Organizations like the IJC can help bring key people and organizations together that are not always working well together. GEO tries to do that. There is not a lot that is new on GEO programs, but it tries to integrate people and programs in other organizations. SAON is trying to play this organizing role.

- There is a need to harmonize and represent science that doesn't stop at the border and this is something that the IJC is advancing elsewhere through its International Watershed Initiative (IWI). Under IWI, the Commission found a need to harmonize data on both sides of the border. Progress is being made. Anything that comes out of this

that moves toward data harmonization will be well received by IJC. Regular measurements need to be harmonized on both sides of the border and the science should be responsive to regulatory requirements.

The discussion turned to the question of the *Canada-US Air Quality Agreement (AQA) and possible roles for the IJC and the IAQAB in the northern airshed*. The following key points arose:

- There is a need to look at transboundary air quality coming into both regions.

- The public's perception is that the AQA does not pay enough attention to air issues in the west (or south or north). This has been reported to the governments three times now but has not been addressed. This suggests the need to think of another pathway beyond the AQA. That said, it is not clear that the AQA doesn't/couldn't address the west; it just hasn't been effective thus far.

- The Agreement is about holding the US and Canada to their obligations on air quality, but it doesn't address the transboundary air issues. It was suggested that the IJC could be used to promote air quality monitoring and cooperation in this transboundary region and could include provinces and states.

- The southern AQA doesn't specifically include native peoples, but anything that is developed for the North must do so. There are some things that could be learned from native communities in the US that have been addressing their own air issues.

- Northern researchers need to find out who is working on a PM annex and work with them to ensure that there is input re: northern air concerns. A new international agreement is not necessary but a work plan is.

- There is interest in promoting better monitoring in the North and further collaboration between scientists who are studying Mercury and other air contaminants. Could the IJC be an advocate for the necessity of a binding agreement for controlling air pollutants?

- While air quality legislation is in place in the northern boundary region, monitoring, reporting and enforcement are lacking. This results in open garbage burning throughout the territory which creates all sorts of air problems. There are some stronger requirements in new permits; however, the political will seems to be lacking.

- The National Parks Service (NPS) is active in air issues because there is a federal mandate to deal with air quality and haze. Class 1 areas – parks over a certain size such as Denali have monitoring of air quality; however, it's tough to get the list expanded, although there are a few Native American areas now included as Class 1 areas. The public is behind this because visitors don't want to go to the Grand Canyon and be

unable to see across it. From this mandate have come haze controls and other positive air quality controls/improvements.

- Canada has focused on levels of contaminants in air, not on visibility.

- Present AQA negotiations seem to have been limited to asking what the respective countries can do within their own jurisdiction to make improvements in air quality. Now they are talking about visibility and thus lower PM levels and this is helpful, but goals for standards are not strict enough. Negotiation about the amendments to the AQA will be helpful in the south, but not in the north because the transboundary issues are not the primary concerns in the North (which are mainly local). Perhaps the IAS (international airshed) could be used as a model. There needs to be a strong commitment from participants; don't need the AQA: in other words, "just do it." The Air Quality Agreement is between two nations, but the IJC could include provinces and states in the collaborations.

- There are 800 NGOs in the Yukon and some should be included: e.g., Yukon Conservation and others.

- There are funding organizations that have been active and could be viewed as potential collaborators, including the Wolf Creek watershed, cold regions modeling, the Yukon environment and others.

- It would be worth documenting the institutions, organizations, agencies and informal arrangements that are operating in the north, including World Heritage sites, intertribal watersheds, BC parks, Arctic Institute, northern contaminants, fisheries treaty, porcupine-caribou management board and others. Is there a linkage to air quality in any of these?

- The IJC could promote cooperation from the ground up to the international front.

The Session Chairs then asked workshop participants for their views on how to continue this discussion with the "community of practice" in the US and Canada in the northern and western border region.

Joel Weiner, Senior Adviser, Canadian Section, IJC: "Closing Remarks - Perspectives from the IJC"

Mr Weiner thanked the participants for their valuable contributions and suggested that the Air board work with IJC staff to synthesize all the science presented here and see how it meshes with the critical policy considerations. The Board will prepare a report which brings together

the input from both the Anchorage and Whitehorse workshops to provide cogent, practical, efficient recommendations to the IJC.

3.0 Conclusions

The following conclusions arose from the meeting presentations and ensuing discussion.

Sources:

1. Northern transboundary air quality impacts from Canadian and Alaskan air emissions are likely minimal currently; however, as industrial development increases so does the potential for northern transboundary air quality impacts. There is a growing interest in hard rock mining, open pit mining, and more power generation.
2. Major local sources of aerosols in Alaska and probably the Yukon include road dust, indoor air quality, resource development, diesel generators, and open burning of solid waste. The effects of air pollutants on local resources and human health in the north are not the same as experienced along the southern boundary and will require unique solutions to minimize impacts on the ecosystem and human health.
3. Aged polluted air from Asia and from international ship lanes reaches Alaska and what happens to these ship emissions differs from that known for mid-latitudes. Advection of pollutants from ship emissions contributes temporally to SO_2, SO_4^{2-} increases and enhanced ozone advection/formation occurs along the Alaska panhandle. Control of ship emissions is important to mitigate air pollution in the north. The trans-boundary nature of the international aerosols means that international cooperation will be required to reduce the quantities of those aerosols.
4. Several toxic contaminants (e.g., POPs and mercury) are transported long range into Alaska and into the Yukon from Asia, Russia and south-western provinces and states in North America. These toxic substances enter the ecosystem and accumulate to high levels in biota (especially marine mammals and fish).

Prevention, Control, Abatement

5. Oil spill damage in the north is something which we should expect as exploration and extraction increase. Conditions at northern spill locations will be much different than experienced in the Gulf of Mexico. Systems should be developed to prevent an event of this type or magnitude from occurring in the future and tools for appropriate emergency response should be developed, thoroughly tested, and simulated response exercises conducted regularly.
6. New energy systems (to replace existing hydrocarbon-based energy generation processes) are very promising but require more research and development and care in implementation. Nevertheless, a cold climate can be a big advantage for some of the systems. Multi-national collaborations/analogues are critical for new systems development.

7. Decreasing aerosols from local sources will require local regulatory action, common sense and going after the 'most bang for the buck' sources first.
8. Inuit are among the most exposed/affected people of the world with respect to environmental chemicals and need to be more included in discussions which affect their future. Global agreements are essential for protecting minority groups and partnerships between the ICC and some national governments and international organizations are a positive model for others to follow.

Monitoring and Modeling:

9. Models and monitoring are complementary. Current models focus on transboundary transport of pollutants, examine urban and global scales, forecast storm surges, sea ice movement, movement of volcanic ash, surface pollutant concentrations and upper level ozone and solar radiation) and for simulate movements of smog, acid deposition and air toxics.
10. Lichens and passive sensors have been used effectively in the north to evaluate impacts on the ecosystems exposed to pollution from shipping and long-range Eurasian smelters and coal fired generators. Data from 1998-2008 indicate there is significant change in deposition in some areas of Alaska; however, the changes are complex. This monitoring needs to continue.
11. Air pollutant issues (e.g., particulates and other aerosols, toxics, NOx and SOx) should be linked with climate change science to better understand changing conditions in the North and how these changes affect transport, fate, deposition and effects of these substances on biota.
12. Regular and systematic monitoring activities are critical for the ongoing 'effectiveness evaluation' of international pollution control agreements (e.g., the Stockholm Convention and the POPs and Metals Protocols to the Convention on Long-Range Transboundary Air Pollution).

Health Issues:

13. Many northerners rely on fish as a healthy dietary staple and fish consumption levels are high. Action is warranted to ensure the safety of Alaska's and the Yukon's food supply because of its unique nutritional, cultural, economic importance. Advice to northerners needs to be clear, open and culturally sensitive.
14. Concern over toxic contaminants in the traditional food supply as well as social pressures are contributing to dietary transitions among northerners and indicate an increase in consumption of store-bought foods which are high in carbohydrates and low in beneficial fatty acids. Territorial health agencies encourage the continued consumption of traditional foods due to their positive contribution to health. Levels of some toxic substances are declining in traditional foods such as fish and may indicate that global, regional and national controls are slowly reducing deposition of several contaminants in the Arctic and/or that diets are changing.
15. Climatic inversions continue to be problematic in several northern communities (e.g., Whitehorse and Fairbanks) that generate significant amounts of particulates

through the use of space heating with low cost fuels (wood and coal), automobile, and diesel electric generators.

International Cooperation:

16. The IAQAB should continue to facilitate communications among the interested parties in the North through a series of topical web seminars. Useful topics might include, but not be limited to, particulates and gases from local and international shipping (sources, amounts, seasonality, trans-border movement, abatement, etc.).
17. We should continue to encourage US and Canadian jurisdictions, First Nations and Tribes, and academic and non-governmental organizations in the North to maintain a "community of practice" to exchange information and facilitate transboundary policy discussions.
18. There might be an opportunity to start a cross-border demonstration project, such as joint monitoring for toxic contaminants, even though there is not a formal mechanism under the Air Quality Agreement to support work on toxic contaminants.

Recommendations to the IJC from the IAQAB:

Transboundary Air Issues in the Alaska-Yukon-British Columbia Region of North America

The above findings illustrate that the people of the Alaska/Yukon/British Columbia border region are concerned about air pollution and feel they have a stake in further discussions of the topic and in understanding the impacts of future development in the region versus those caused by global pollution. Northerners are interested in taking steps to manage their airsheds and recognize that these may be binational in nature. They would welcome the continued involvement of the IJC as a mechanism to assist with defining the issues and helping to link the local issues to the wider context of air pollution.

Recommendation 1: The northern regions of developed countries hold a major stake in understanding implications of pollution as well as methods of addressing specific issues. The IJC should propose to governments that they will more clearly define priority air quality issues along the Canada/US Northern border and will come forward with suggestions to governments as to how these can be managed. The definition of priority air quality issues could be set either under the existing AQA through listening sessions on both sides of the northern border or instead by providing IJC a mandate to create a Northern Boundary task force to prepare a roadmap identifying the priorities, documenting the ongoing efforts that may address the priorities and options to move forward.

Recommendation 2: Issues along the Northern Border differ from those covered by the Canada/US Air Quality Agreement for the southern border. There is little evidence of acid rain, which is the cornerstone of that agreement, and little concern over ground-level ozone, but a

major concern with toxic pollutants. The Northern Boundary shares concerns over particulate matter with the Southern Boundary, but the sources, pathways and fate may be very different.

Recommendation 3: In order to move forward, the IJC should propose continued development of a "community of practice" in this northern region between its governments, First Nations, Tribes and Inuit, academics and non-governmental organizations. This could give an indirect impetus to such communities, which are typically self-forming.

The findings illustrate that more needs to be done by both countries to measure and model air quality in the North in order to establish the priority air quality issues.

Recommendation 4: Issues that need to be considered should include (but not be limited to) particulates and gases from local and international sources, persistent organic pollutants (POPs) and metals, greenhouse gases and traditional pollutants.

Recommendation 5: In view of the binational nature of pollutants in the North, governments should be encouraged to work binationally to establish harmonized measurement and modelling programs to better understand the issues, set priorities for action and assess management measures taken. The IJC can take a role in defining these and encouraging governments to take action. One such example is pollution from ships, where Canada and the US have collaborated on the Emission Control Area submission on ship emissions to the International Marine Organization (IMO).

Recommendation 6: The IJC should congratulate governments for their binational approach to management of ship emissions and propose that similar approaches be used for other air quality issues in the North. For example, reducing locally-created aerosol pollutants that can be transported across borders may require collaboration to identify local sources and to develop control policies suitable for northern areas.

Recommendation 7: Recognizing that the source mix is different in the North than in the South, and emissions related to energy production are important, the IJC may wish to encourage governments to develop and test new energy generation systems which work effectively in northern conditions and are less polluting.

Recommendation 8: Air quality along the Northern border is influenced by global air quality and groups such as the Inuit are exposed to several harmful POPs and metals, especially mercury. Recognizing this finding, it will be important to ensure that progress on management of global pollutants as reflected in multinational agreements is understood in the context of the Northern border and that Northerners engage appropriately in international discussions and negotiations that can affect their air quality.

Recommendation 9: The IJC may wish to encourage the government of the United States to ratify international agreements such as the Stockholm Convention on Persistent Organic Pollutants and the United Nations Economic Commission for Europe's Convention on Long Range Transport of Airborne Pollutants (UNECE LRTAP) Protocols on POPs and Metals.

Recommendation 10: The IJC may also wish to encourage both governments to participate vigorously in the negotiations over a Global Agreement on Mercury.

Recommendation 11: The IJC may wish to encourage governments to make best possible use of partnerships between indigenous groups such as the Inuit Circumpolar Conference to promote global control of chemicals and metals which can cross borders and affect health.

Appendices

1. Meeting Agenda for Whitehorse, Yukon (August 17-19, 2010)

DAY 1: Morning - August 17

9:00 am – 12:00 pm
9:00 am Welcome and Introductions:
Jon Bowen, Director, Environmental Programs, Environment Yukon
John Mayes, Canadian Section member, IAQAB
Lana Pollack, US Chair, International Joint Commission

Session I: Setting the Stage

9:15 am IAQAB Overview of the Consultation Ann McMillan, *Canadian Co-Chair, IAQAB*, **John Mayes**, *Canadian Section member, IAQAB*
9:45 am Dave Fox, *Air Pollution Management Analyst, Environment Canada* -Development in Canada's North
10:15 am Rick Artz, *Deputy Director, NOAA - Air Resources Laboratory* - The Deepwater Horizon disaster and emerging air quality issues
10:45 am – Health Break
11:00 Chad Gubala, *Director*, *Alaska-Canada Research Innovation Centre* - Adapting Technologies to address cold climates and climate change in the North
11:30 am Carl Sidney, *Chairman*, *Yukon River Inter-Tribal Watershed Council* – We Live By the River, Video Documentary
12:30 pm - Lunch Provided

DAY 1: Afternoon - August 17

2:00 pm – 4:00 pm

Session II: Local and Long-Range Air Pollution Sources *Moderator – Rick Artz*

2:00 pm Hayley Hung, *Research Scientist, Process Research Section, Air Quality Division, Science and Technology Branch, Environment Canada* – Atmospheric Organic Pollutants and Mercury in the Arctic: Recent Findings from the Northern Contaminants Program and the International Polar Year Project of Intercontinental Atmospheric Transport of Anthropogenic Pollutants to the Arctic (INCATPA)
2:30 pm Nicole Molders, *Chair of the Department of Atmospheric Sciences, University of Alaska Fairbanks* - Impact of unregulated ship emissions on air and water quality in southern Alaska
3:00 pm - Health Break
3:30 pm Cathy Cahill, *Associate Professor, Geophysical Institute and Department of Chemistry University of Alaska Fairbanks* – Transboundary Atmospheric Transport: Local vs. Long-Range Air Pollutant Transport
4:00 pm - Adjourn

DAY 2: Morning - August 18

9:00 am – 12:00 pm

Session III: Human Health and Air Quality in the North *Moderator – Kathy Tonnessen*

9:00 am Lori Verbrugge, *Environmental Public Health Program Manager, Department of Health and Social Services, State of Alaska* - Update on human biomonitoring projects to assess mercury exposure in Alaska
9:30 am Jay Van Oostdam, *Senior Epidemiological Advisor, Chemicals Surveillance Bureau, Healthy Environments and Consumer Safety Branch, Health Canada* – Human Health Implications of Environmental Contaminants in Arctic Canada
10:00 am Eva Kruemmel, *Senior Health Research Officer, Inuit Circumpolar Council* - International Agreements on Global Contaminants and Implications for Inuit Health
10:30 am – Health Break

11:00 am Troy Ritter, *Senior Environmental Health Consultant*, *Alaska Native Tribal Health Consortium* - An Overview of Air Quality Issues of Interest to Alaskan Native Peoples
11:30 am John Dellinger, *US co-chair, Health Professionals Task Force* - Risks and Benefits of Consuming Great Lakes Fish
11:45 am - Lunch Provided

DAY 2: Afternoon - August 18

1pm – 4:30pm
Session IV: Air Quality Monitoring and Air Modeling Studies of Air Contaminants *Moderator – Harold Garabedian*
1:00 pm Dave Schirokauer, *Biologist, Natural Resources Program Manager Klondike Gold Rush, National Park Service*
Federal efforts at remote air quality monitoring sites within the State of Alaska
1:30 pm Barbara Trost, *Air Monitoring Program Manager, Department of Environmental Conservation, Government of Alaska* - Status of the State of Alaska's Air Quality Monitoring Efforts
2:00 pm Michael Moran, *Research Scientist, Air Quality Research Division, Environment Canada* - Recent Initiatives in Air Quality forecasting and policy-related modeling in Canada
2:30 pm Sandy Steffen, *Physical Scientist & Atmospheric Mercury Specialist, Environment Canada*- Mercury Behaviour in an Arctic context
3:00 pm – Health Break
3:30 pm Jason Stow, *Environmental Scientist*, *Indian and Northern Affairs Canada* – Current Activities of the Northern Contaminants Program and Arctic Monitoring and Assessment Programme (AMAP) and how they relate to northern issues Air Modeling for Contaminants
4:00 pm Aileen Stevens, *Air Quality Programs Coordinator, Department of Environment and Natural Resources, Government of the Northwest Territories* – Air Management in the Undevolved Territories
4:30pm - Adjourn
5:15 pm Evening Boat Cruise on the Yukon River, onboard the MV Schwatka

DAY 3: Morning – August 19

9am - 12pm
Session V: Bi-national Consultation *Facilitators, Ann McMillan/Gary Foley*
9:00 am Updates on International linkages. Gary Foley, US Co-Chair, IAQAB (GEOSS) and Ann McMillan, Canadian Co-Chair (SAON) – 10mins each.
9:20 am Facilitated discussion on the utility of the Canada-United States Air Quality Agreement to address transboundary air quality issues, specifically, the transboundary region between Alaska and British Columbia/Yukon
11:00 am Potential role(s) for the IAQAB in supporting binational interactions along the northern border?
11:30 am Closing Remarks - Perspectives from the IJC, *Joel Weiner, Senior Adviser, Canadian Section, IJC*
12:00 - Lunch Provided

DAY 3: Afternoon – August 19

1-4 pm, Guided Tour: Little Fox Lake's Air Quality Monitoring Station (Chad Gubala/Hayley Hung)
Little Fox Lake is one of two Canadian air quality monitoring sites taking part in the Intercontinental Atmospheric Transport of Anthropogenic Pollutants to the Arctic (**INCATPA**) project measuring toxic chemicals produced from human activity and carried through the air to the Arctic. As these chemicals reach the Arctic, they fall to the ground, potentially affecting the health of both humans and animals. This project will help to determine where these chemicals have come from and how the weather influences their presence in the Arctic. The chemicals are also being measured in the air around the Pacific Rim countries of China, Vietnam, Russia and United States.
Resource link:
http://www.ec.gc.ca/api-ipy/default.asp?lang=En&n=8EBD7558-1

2. List of Attendees – Whitehorse, Yukon Expert Consultation, August, 2010

Artz, Richard IAQAB, NOAA
Cahill, Cathy University of Alaska, Fairbanks
Church, Ian Retired Public Servant
Dellinger, John US co-Chair IJC Health Professional task Force
Eakins, Jennifer Yukon Department of Environment
Edwards, Alice Alaska Department of Environmental Conservation
Edwards, Michelle Indian and Northern Affairs Canada
Foley, Gary US co-Chair IAQAB, Environmental Protection Agency
Fox, Dave Environment Canada
Garabedian, Harold IAQAB, State of Vermont
Gubala, Chad Alaska-Canada Research Innovation Centre
Henry, Catherine Access Consulting Group
Houston, Jim International Joint Commission
Hung, Hayley Environment Canada
Jensen, Shannon Yukon Department of Environment
Kinnear Lacia, Yukon Research Center of Excellence
Kostelnik Janine, Yukon Department of Environment
Kruemmel Eva, Inuit Circumpolar Council
Mayes, John, IAQAB, Ontario Environmental Sciences and Standards Division,
McMillan Ann, Canadian co-Chair IAQAB, Environment Canada
Middleton Francis, Yukon River Inter-Tribal Watershed Council
Millar Nathan, Yukon Department of Environment
Molders Nicole, University of Alaska, Fairbanks
Moran Michael, Environment Canada
Pollack Lana, US Chair, International Joint Commission
Ritter Troy, Alaska Native Tribal Health Consortium
Roach Pat, Indian and Northern Affairs Canada
Schirokauer Dave, National Park Service
Schwarzhoff Peter, Meteorological Service of Canada
Sidney Carl, Yukon River Inter-Tribal Watershed Council
Smith Johanna, Yukon Department of Environment
Sidney Carl, Yukon River Inter-Tribal Watershed Council
Steffen Sandy, Environment Canada
Stevens Aileen, Government of the NWT
Stow Jason, Indian and Northern Affairs Canada
Tonnessen Kathy, IAQAB, National Park Service
Trost Barbara, Alaska Department of Environmental Conservation
Truelson Bob Manager, Department of Environment
Van Oostdam Jay, Health Canada
Verbrugge Lori, Alaska Department of Health and Social Services
Weiner Joel, International Joint Commission
Whyte Lauren, Yukon River Inter-Tribal Watershed Council