INTERNATIONAL AIR QUALITY BOARD

Expert Consultation Meeting

air quality issues related to the northern boundary region between the United States and Canada

Held at the

National Park Service Regional Office

Anchorage Alaska

Sept 9-10, 2008

Special Thanks

Following the two days of consultations in Anchorage, Alaska representatives of the International Joint Commission and the International Air Quality Advisory Board visited Denali National Park and the Healy Coal Plant to receive briefings on air quality monitoring in the park and potential emission reduction technologies for use at the plant.

Special thanks to Bud Rice and Andrea Blakesley of the National Park Service for making the arrangements.

Preface

The Boundary Waters Treaty of 1909 that created the International Joint Commission (IJC) refers to a "common frontier" between the United States and Canada. Our international boundary in the far north is possibly the only stretch of the border that can still be referred to as a "frontier". Certainly, because of its remote location, both air and water quality concerns in this northernmost transboundary region don't always get the binational attention they deserve.

That's why I was pleased to join scientists and government officials from Canada and the United States at an expert consultation focusing on air quality issues along the border shared by Alaska, the Yukon and British Columbia. Based on what I heard, it was clear that because of increasing air pollution from the Far East, emissions from active volcanoes in the Alaskan archipelago, and the impact of climate change in the Arctic, among other issues, this region deserves more joint attention.

I urge policy makers in the U.S. and Canada to review this report and the recommendations based on it that have been developed by the IJC's International Air Quality Advisory Board. They reflect both a serious commitment to understanding the science and a serious intent to protect air quality in this unique ecosystem that is precious to both countries.

Allen Olson,
U.S. Commissioner, International Joint Commission

Executive Summary of Conference Findings and Recommendations

The International Joint Commission (IJC) International Air Quality Advisory Board (IAQAB) convened an expert consultation in Anchorage, Alaska, to discuss air quality issues related to the northern boundary region between the US and Canada. The US National Park Service-Alaska Regional Office played a key role in organizing the consultation. Over 40 participants attended the event.

Air quality issues identified were divided between local and long distance transport of pollutants including natural sources those related to human activity. In the north, volcanic and forest fire emissions, *Arctic haze*, industrial emissions from circumpolar and Asian sources were important issues that could have both short and long range transport. Local sources included: vehicle emissions trapped by inversions leading to ice fog; smoke from wood heating; dust from vehicle traffic on unpaved roads and airstrips; emissions from non-regulated off-road vehicles; cruise and commercial marine emissions; industrial pollutants; incineration for garbage disposal; and benzene fumes escaping from locally formulated transportation fuels. It was noted that indoor air quality issues during winter months may have greater impact on human health than outdoor air quality since people tend to remain indoors with poor ventilation being a contributing factor.

A good overview of the monitoring and modeling programs in place in this region to study air quality was obtained. Programs in the north have more emphasis on impacts on human health than those in many parts of the south since toxics can bioaccumulate in the food chain.

The consultation resulted in a number of observations and findings:

1. There is considerable ongoing research in this border region shared by southeast Alaska, northern British Columbia and the Yukon; however, no standing binational forum exists for the coordination of effort or exchange of information. General consensus among participates was there needs to be an effort to build on this event and establish a standing binational forum for researchers to present locally.
2. Northern air quality issues, especially those related to energy production, are domestic, binational and international in scope. Therefore, addressing these issues requires a comprehensive and coordinated transboundary approach that not only engages all relevant government agencies and research organizations in Alaska, northern British Columbia and the Yukon but also encourages their much needed interaction and coordination with international initiatives if they are to be successful in addressing their domestic and binational air quality issues (see #5 for global dimension).
3. Contaminant loadings to the environment have a uniquely different impact in this region because they affect regional fish and wildlife which are an important local source of food, especially for native people.
4. Along the US-Canada border in the north, continued vigilance is necessary to ensure appropriate monitoring networks are in place, not only air quality monitoring but also monitoring for contaminants in fish tissues, for example.
5. Since long range transport pollutants are of a global scale and impact on local and regional air quality and ecosystem health, the IJC parties should seek to jointly formulate strategies and approaches for mitigation to promote at the international level.

6. It was reported that the economies of the northern region are changing. It is anticipated there will be increased development of large-scale extractive industries in currently undeveloped areas. This possible development includes hard rock mines, gas and oil pipeline and energy facilities. It was further reported that there are regulatory uncertainties that need to be addressed to allow for responsible development. The significance of developing these extractive industries is large and wide-scale. Impacts of such development are not only felt throughout the northern region but could be felt throughout North America.

Subsequent to the meeting in Anchorage with Alaskan and western Canadian air quality experts, the IAQAB had further discussion of the outcomes of this event and developed these recommendations to the Commission:

1. The International Joint Commission should support further efforts by the IAQAB to continue the dialogue started in Anchorage and to engage more researchers from both sides of the border. To continue this discussion a subsequent expert consultation in the north, on the Canadian side of the border, is recommended.
2. The goal of future discussion should be the development of specific recommendations as to how the governments of Canada, the U.S, Alaska, British Columbia and the Yukon could develop cooperative binational programs for cross boundary monitoring and research related to air quality.
3. To properly address global pollution issues, such as mercury, communication between countries is vital to foster an understanding of the implications of pollution as well as methods of addressing specific issues. The northern regions of developed countries hold a major stake in this discussion and need dedicated fora to explore the issues.
4. Monitoring networks and observational data are fundamental to acquiring the transboundary data that is required to understand the air pathway of pollutants. Working together, Canada and the US should fulfill their international commitments to monitoring in the North.
5. There are a number of specific issues that warrant further consideration across the northern border. Some of these are:
    a. In order to better understand and respond to the transport of mercury, particulates and greenhouse gases from forest fires in the region, the U.S. and Canada should support the required research and the development of improved modeling tools.
    b. Tracking of trends of air pollution is important in the context of development and climate change. In this regard, a goal of binational reporting of pollution in the border region should be considered.
    c. Emphasis should be put on using similar methods and approaches to measure and model air pollution on both sides of the border.
6. The reported regulatory uncertainties associated with large- scale extractive industries should be reviewed by the jurisdictions of interest and appropriate actions taken as developments of this scale and magnitude can result in the large scale emissions and long range transport of air contaminants, including transboundary transport of emissions. A report on this matter should be invited for presentation at the next expert consultations in the north.

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.

Introduction

On September 9-10, 2008 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. Previous consultations by the IAQAB had taken place in the Washington State/British Columbia border region but had not extended its analysis into the northern transboundary region until this meeting. The Board was interested in hearing from technical experts from Alaska and western Canada on significant air quality issues associated with local, regional and trans-Pacific sources of air pollutants. Because the northern and rural nature of the border region between Alaska and Yukon/British Columbia, the issues associated with human health and ecosystem effects of air pollution are also different from the rest of the United States and Canada. The Board wanted to hear 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. Recommendations by the IAQAB members based on these discussions are included at the end of this document.

Meeting Proceedings and Synopsis of Presentations

The following is a synopsis of the presentations at the workshop.

After introductions, US Commissioner Allen Olson brought greetings from the other five IJC Commissioners. He commented that air quality is one of a number of transboundary issues within the purview of the IJC, whose mandate includes the shared border of Alaska and Yukon/British Columbia, not just the lower-48 U.S. and Canada.

John Quinley, National Park Service, Alaska Region, Assistant Regional Director, welcomed the assembled air quality experts, on behalf of the NPS Regional Director.

The U.S. National Park Service (NPS) supports and maintains air quality monitoring networks throughout the US, with some sites in Alaska. NPS monitors visibility, wet and dry deposition and ozone at limited sites in Alaska, but these sites have generated some of the longest air quality records for the state. Much of the monitoring at both NPS sites and US Fish Wildlife Service sites is motivated by the status of these protected areas as Class 1 areas, as designated by the Clean Air Act amendments of 1977.

Ann McMillan and Gary Foley, the Canadian and American co-chairs of the IAQAB, reviewed the role of the Board and indicated their 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.

SESSION 1: Long Range Transport of Contaminants and Possible Sources

Harold Garabedian, IAQAB member from the State of Vermont, opened the session by discussing two goals of the workshop: (1) production of a report to commissioners, and (2) local network creation to continue dialogue regarding air quality issues.

Cathy Cahill, University of Alaska, Fairbanks: *"Sources and Transport of Aerosols in the Arctic".*

Dr. Cahill discussed long range transport of aerosols and how these affect local air quality in Alaska. Everyone is downwind and up wind of someone else. Local air quality can be affected by transport from seemingly unlikely sources. For example, it has been shown (see Figure 1) that air masses over Greenland can contain aerosols from the Sahara or Alaska can receive air masses from India. Local air quality improvements can be thwarted by air masses originating from remote locations with poor quality. International policy needs to address these issues, e.g. international treaties. To begin this dialogue, the western, developed countries need to take responsibility for their contaminant contribution before others can be expected to do the same.

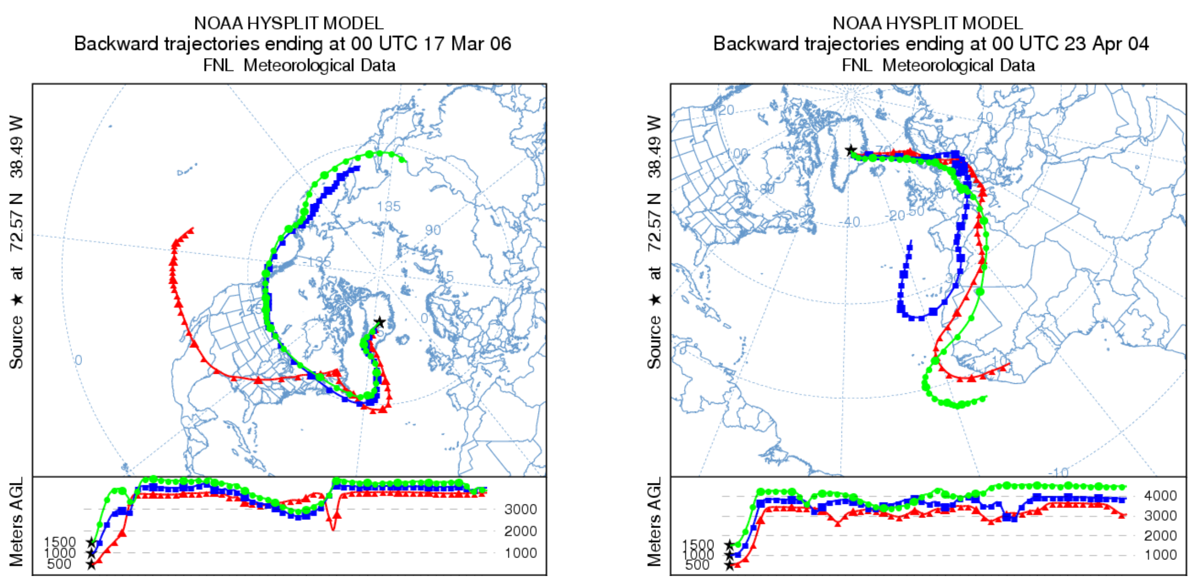


Figure 1: HYSPLIT trajectories for Alert Station in Greenland. These backward trajectories show how local air masses can originate from vastly different areas.

Dr. Cahill also commented on the natural sources of aerosols in northern US and Canada: fires, oceans, volcanoes, and Asian dust. The summer of 2008 was the exception with respect to forest fires that affect Alaska and arctic Canada most summers. The number and intensity of wildfires in the boreal forests have increased due to climate change. In the north the albedo (i.e. the whiteness) of glacial ice is changing due to particulate deposition. Along the coasts of Alaska and northern Canada, there is less sea ice and more storms along the coasts that enhance the airborne salt spray and out gassing of persistent organic pollutants from the oceans. Volcanoes erupting in Alaska produce mercury (Hg) and particles. Gobi Desert dust from central Asia is enhanced due to climate change, with observations of dust and industrial emissions from China, and eastern Asian (metals, sulphur, black carbon) being strongly transported to western North America is the spring. In China there are more sources of air pollutants being built daily; since 2005 it is estimated the equivalent of three or four 500 megawatt power plants have been coming on line every week, many with state-or-art equipment. However, the emissions data suggest that many of the plants equipped with environment cleanup technologies are not being operated on a regular basis to offset the rising coal prices[1]. During spring in the northern hemisphere, there are enhanced aerosols in suspension and these are deposited globally.

In winter there are temperature inversions in Fairbanks and other northern urban areas, so local air pollution sources are extremely important to PM 2.5 violations. At present increased wildfire smoke doesn't seem to be correlated with high human health effects (asthma, hospital admissions, etc.). We are not sure why. Peat fires do cause human health effects based on 1997 Indonesian wildfire emissions studies.

Carven Scott, National Oceanic and Atmospheric Administration, National Weather Service: *"A New WRF/CHEM Wildfire Smoke Forecast System for Alaska".*

Dr. Scott discussed wildfire smoke dispersion models. An example of one model output from the Fairbanks area is shown in Figure 2. He noted that better models are needed and being developed to examine long range transport issues. Some regulatory agencies need outputs from these smoke models for air quality forecasting while others use the outputs as a decision-making tool for forest fire control operations. He noted that in Alaska there were three volcanic eruptions (2 explosive) in the last two months.

[1] cited from Greener Plants, Grayer Skies? A report from the front Lines of China's energy sector: Steinfield et. al. , 2008 (http://web.mit.edu/ipc/publications/pdf/08-003.pdf)

In additional to producing smoke, particulates, pollutants, and enhanced gas concentrations (mercury and carbon monoxide), in 2004, North American forest fires contributed carbon dioxide to the atmosphere that was equivalent to that year's industrial emission sources.

Fire forecasting maps are based on drought forecasts, snowfall, thunder storm frequency, and 'fuel' maps. In 2008 Anchorage had its 3rd coolest summer in 100 years, and therefore there were few wildfires. One thing that may be explored in future discussions are the differences in prescribed fire and fire suppression activities in the US and Canada.

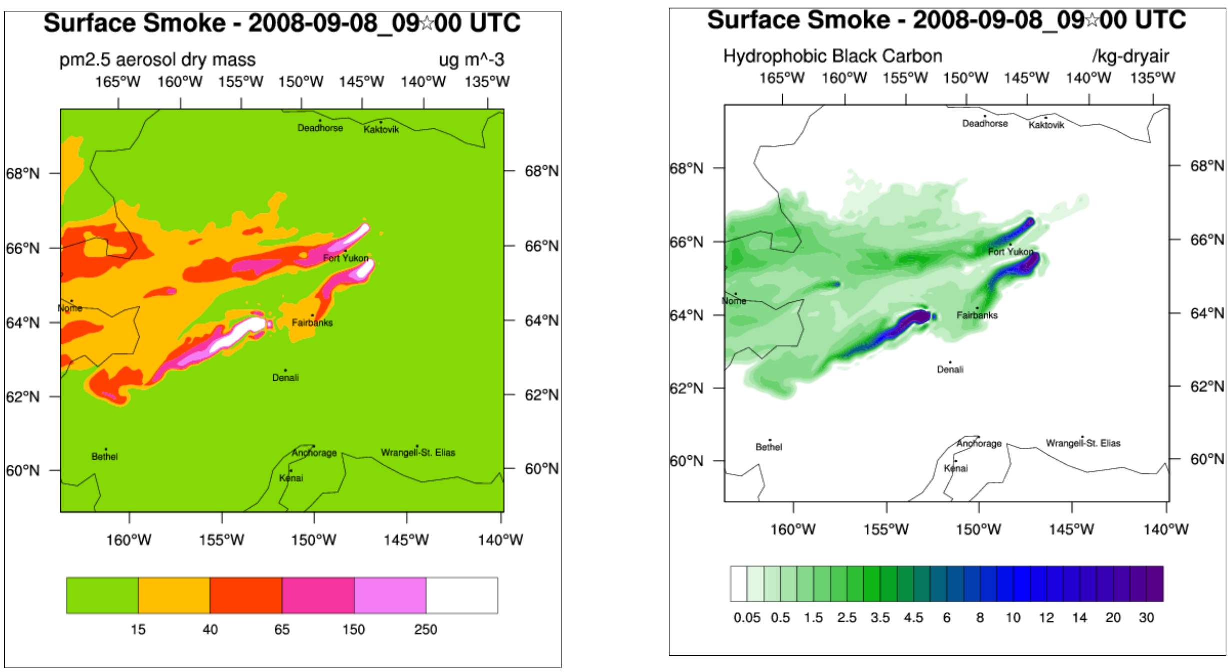


Figure 2: Examples of WRF/Chem model outputs for the Fairbanks area showing surface smoke containing PM2.5 aerosols and black carbon surface distribution.

Brian Wiens, Air Quality Modeling Applications, Meteorological Service of Canada: *"Canadian Forest Fire Smoke Forecasting".*

Mr. Wiens discussed forest fire smoke forecasting that is needed to protect the health of exposed populations, to determine impacts to visibility, and to assess climate impacts. Forest fire smoke is not confined to a region but has implications for international air quality agreements. Better models that include emissions data and plume rise are needed to improve air quality forecasting. Smoke forecasting models were developed for use by firefighters to allocate resources, for example which 'flank' of the wildfire should be suppressed to reduce smoke effects downwind.

Estimating atmospheric emissions from forest fires is an important area for work. An example is shown in Figure 3. At forest fire temperatures mercury is emitted in gaseous form. Understory peat fires have entirely different emissions than from upper story fires and there are diurnal differences in smoke characteristics. To further refine the models used in smoke forecasting, we need more experiments. To make progress in smoke forecasting, we need (1) development of more sophisticated trajectories, (2) real-time modeling of emissions, and (3) better interagency and US/Canada coordination in developing and using these models.

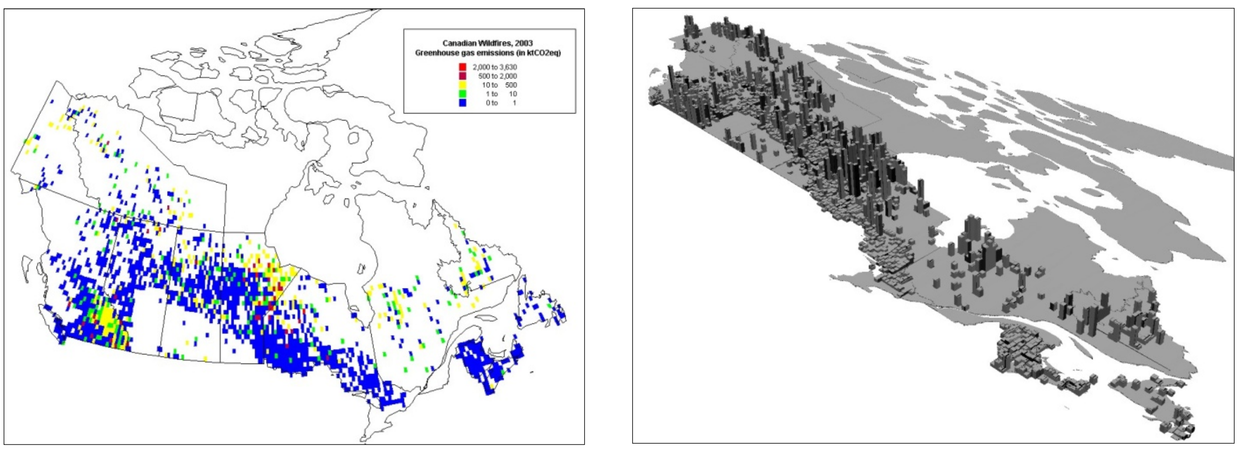


Figure 3: Forest fire emissions from 2003 in Canada modeled at a fine scale of detail (0.4^o grid). These data are a retrospective view of emissions due to the massive computational time required for analysis.

Dave Fox, Air Pollution Management Analyst, Yellowknife, Northwest Territories, Environment Canada: *"Air Issues in Northern Canada".*

Mr. Fox discussed how air quality issues are addressed in northern Canada due to differences in federal and territorial law. Northern Canadian economics are changing which means there will be increased development of extractive industries in currently undeveloped areas as illustrated in Figure 4. These possible, future developments include hard rock mines, possible gas and oil pipelines, and energy facilities built along the Arctic coast. Regulatory uncertainties will need to be addressed to allow for responsible growth in northern Canada. Mr. Fox focused his presentation on Nunavut and Northwest Territories, which had their jurisdictions split 10 years ago. These areas include about 0.25% of the Canadian population. Currently, mining is booming, and oil and gas development is about to expand. There are many isolated work camps and each has its own generators and incinerators. Power generation for these camps is generally supplied by uncontrolled diesel generation – local only, no grid. The Beaufort Sea is a major oil and gas area, but there is no pipeline yet to get the resources to market. There is a deepwater port facility proposed for Bathurst Inlet. Nunavut has no all weather roads; some winter roads operate for about two months over snow and ice, but the utility of these roads is threatened by climate change and mid-winter thaws. Mines will become the greatest source of emissions in Arctic Canada as the number is likely to increase from 5 to 30 over the next 10 years. Because of the harsh environment, there are now dust events every spring. In summer 2008 there was considerable forest fire smoke in NWT/Nunavut. These fires were confined to the boreal forest zone, which often include stunted trees, but there is still thick growth of trees in these areas. Nunavut allows open burning of trash since this region cannot accommodate landfills, due to permafrost. In northern Canada, 95% of land is federal jurisdiction, but air permits are not required. Regulatory inconsistency is a huge problem in the north, where there is a real 'hodgepodge' of regulations.

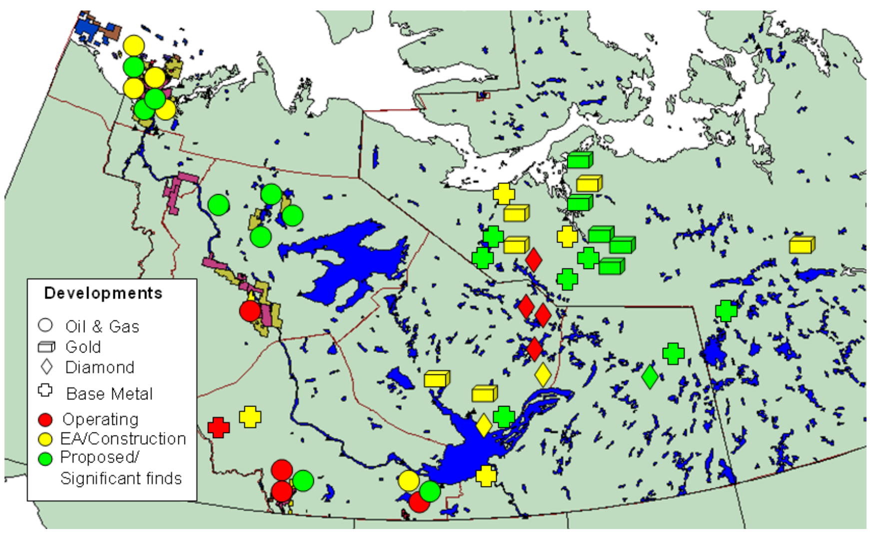


Figure 4: Locations of current, future and proposed extractive industry activities in northern Canada

Dan Jaffe, Professor, University of Washington, Bothell: *"Global Transport of Mercury, Ozone, and Particulate Matter: Policy Relevant Results".*

Dr. Jaffe described his involvement in some of the first measurements and models of Asian dust transport, based on measurements made at the Cheeka Peak observatory on the tip of the Olympic Peninsula in Washington State. Background levels of Asian aerosols are unknown and, there is little understanding of the health impacts of Asian dust. Atmospheric dynamics are different at different latitudes which affects the overall long range transport from source to the affected areas.

Dr. Jaffe focused on mercury as a global pollutant whose behaviour is described in Figure 5. Mercury emissions have been reduced on a hemispheric level, but are projected to rise as more coal-fired facilities are built in Asia. A summary of global mercury emissions is shown in Figure 6. Increased mercury emissions from these plants could be significantly reduced by the use of scrubbers. However, global treaties that address pollution have been historically unsuccessful because they are not ratified or entered into force, so another method of addressing global air pollution is needed.

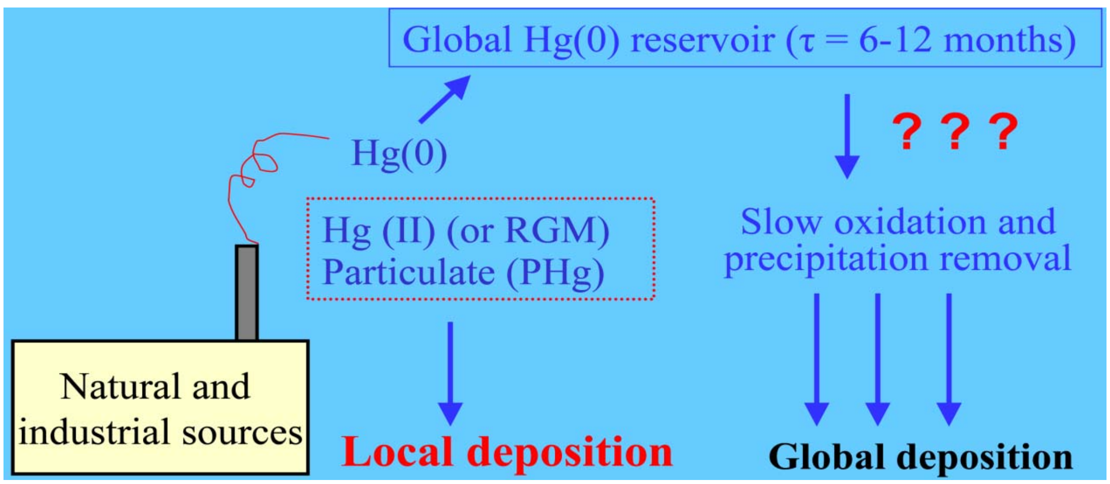


Figure 5: Schematic of global mercury (Hg) behaviour

Any pollutant that persists three weeks or more in the atmosphere (aerosols) will make it around the globe, based on average wind speeds. He has recently been working with a team of researchers at a monitoring station on Mt. Bachelor, Oregon, with monitoring equipment located above 9000' in elevation. This site measures high level air contaminants coming from Asia. His team also uses instrumented aircraft to measure high level dust transport from the Gobi Desert. Globally about 60% of emitted mercury is elemental, 40% is reactive and gaseous. There are principally three classes of mercury emissions: legacy, natural, and industrial. One sixth of all mercury emissions in the northern hemisphere come from Asia. Wet mercury deposition[2] is very large in areas of high precipitation, such as the west coast rain forests of the US and Canada.

[2] Mercury wet deposition involves the transfer of mercury from the atmosphere to land or water through precipitation. For many sensitive surface waters, atmospheric wet deposition constitutes the most significant route of mercury input.

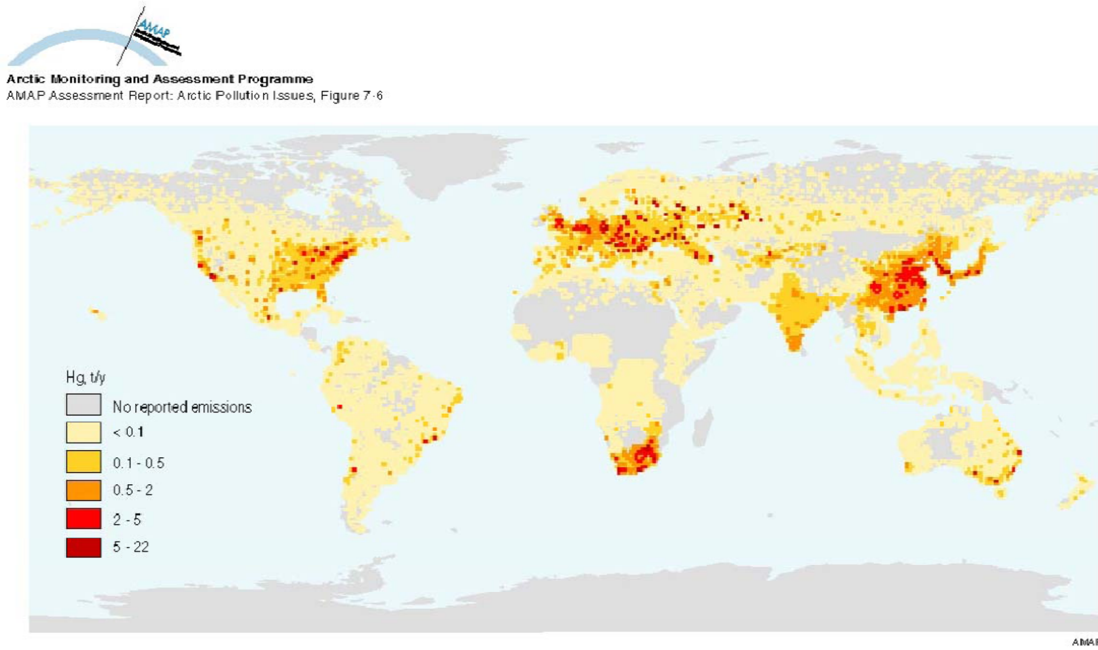


Figure 6: Global distribution of mercury sources. Most sources are in the northern hemisphere and from industrialized countries

Dr. Jaffe concluded that:

- Occasional (about once a year) extreme events of inter-continental transport (due to dust or forest fire smoke) can result in surface concentrations in North America that exceed air quality standards.
- Continuous emissions from Asia make small, but significant contributions to background concentrations of ozone and $PM_{2.5}$.
- Numerous plumes of mercury have been identified that originate from Asia. The data have been used to identify the chemical speciation of the transported mercury, evaluate global chemical transport models and show that the existing mercury emissions inventory is significantly low.
- There are significant mercury oxidation mechanisms that are not well understood.
- While global models do a good job of reproducing observed mercury concentrations, regional models do not, reflecting uncertainty in the oxidation and removal mechanisms for mercury.
- Global models lead to an estimate of 10-20% of the total contribution of mercury to the northern boundary region is from Asian human caused sources; approximately proportional to its global emissions.
- Data show that mercury deposition in western North America has increased significantly but deposition in Alaska is about one tenth of what it is in the lower 48 states. However mercury concentrations in some fish similar to those found in other regions of North America or even greater inland parts of Alaska.
- Concentrations of mercury in all environmental compartments will only be reduced via a global treaty on mercury.

Haley Hung, Research Scientist, Environment Canada, Ottawa: *"Trends of Atmospheric Transport of Organic Pollutants to the Arctic, Monitoring of Persistent Organic Pollutants (POPs) under the Arctic Monitoring and Assessment Program (AMAP)"*

Dr. Hung described the monitoring of persistent organic pollutants (POPs) levels throughout the Arctic region, including sites in Alaska and northern Canada. At these Arctic Monitoring and Assessment Program (AMAP) sites, POPs are decreasing in the atmosphere due to either bans of those chemicals or an overall reduction in use as shown in the left panel of Figure 7. Some banned chemicals, however, are increasing in concentration as shown in the right panel of Figure 7, due possibly to the release of these chemicals from melting sea ice which leads to increased oceanic evaporation.

There are five Environment Canada researchers stationed at the Alert monitoring station in Nunavut, Canada, working on POPs issues. Endosulphans (toxic organochlorine, orchard pesticides) are still detected in the atmosphere in the Arctic. Lindane (banned in 2004 in Canada) has been detected at the Alert monitoring station, but air concentrations have declined since 2004. There is an increasing trend at Alert for PBDEs (polybrominated diphenyl ethers) but very low concentrations for all POPs so very large volumes of air must be sampled to get a 'hit'. New types of air monitors that are self-oriented toward the wind allow for collection of large sample volumes.

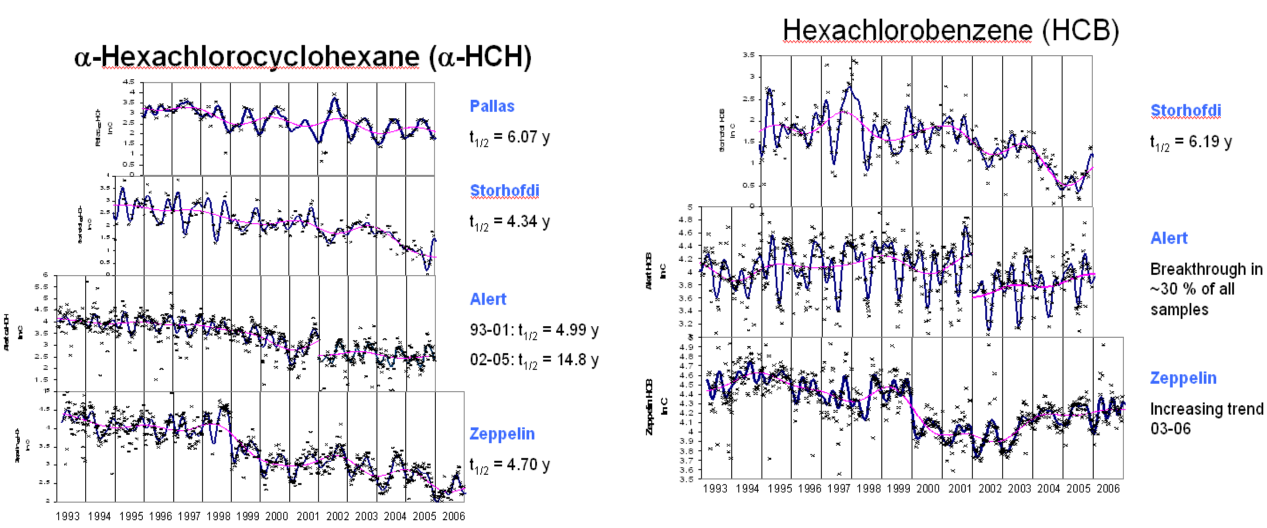


Figure 7: Trends of α-HCH and HCB at different AMAP sampling sites. Both chemicals have been banned. α-HCH shows general decreasing trends as expected, but HCB shows increases at some stations possibly due to evaporation from areas previously covered by by multi-year sea ice.

SESSION 2: Monitoring Air Contaminants

Richard Artz, IAQAB member, with the US National Oceanic and Atmospheric Administration, facilitated the session.

Barbara Trost, Program Manager, Air Quality and Quality Assurance, Division of Air Quality, Alaska Department of Environmental Conservation, Anchorage, AK: *"Air Quality Monitoring in Alaska".*

Ms. Trost discussed how air quality standards enacted for the lower-48 states are not necessarily appropriate for Alaska and showed examples of local air quality issues (see Figure 8). Air quality issues in Juneau and Fairbanks are a result of topography and the methods of home heating. Air pollution regulation is confounded by the fact that most tribal lands are not under federal jurisdiction. Funding for monitoring, control and outreach can come from the State of Alaska and other agencies/groups. Often air quality issues in Alaskan native villages are addressed in a multi-agency manner.

Alaska has a low population density, about 1 person/square mile. Oil production accounts for about 80% of state revenues. There are 229 federally recognized tribes in State, which makes it difficult to regulate across the State, because of differences in governance. There have been improvements in vehicle emission controls since the 1990s, resulting in improved air quality in Fairbanks, Anchorage and Juneau. These three cities are non-attainment areas for national ambient air quality standards. Fairbanks has severe, seasonal air quality problems due to topography/strong inversions. In locations, such as Juneau, there are cold air drainage issues from glaciers that cause dust storms on exposed silt flats which blow from the inland out to the coast. Alaska and the NWT/Yukon policies are not to suppress wildfires unless they threaten private property. Wood stove sales have recently tripled due to high energy prices. Skagway, AK had an air monitoring site pulled after two years of operation because it was not able to detect cruise ship emissions in the harbor. Many native villages don't have wood to burn for heat, so they use diesel fuel for heating; however, the cost is $10 per gallon. Alternative energy sources, such as wind, tidal and geothermal energy, are being investigated by state regulators, especially for multiple locations that are "off the grid".

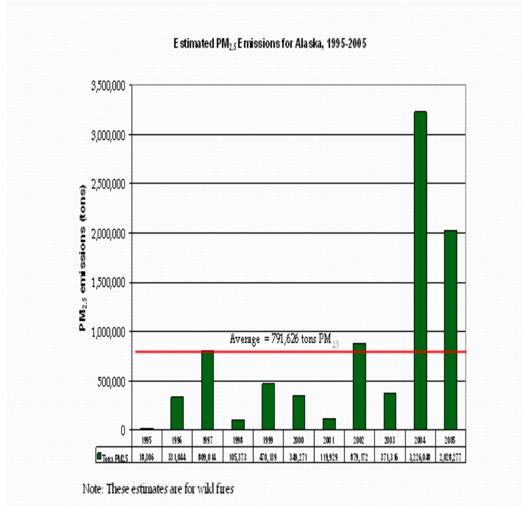
Figure 8: Two examples of air quality issues in Alaska. On the left, someone is shielding their mouth and nose against road dust lofted by passing traffic in the village of Kotezebue. The image on the right is a typical example of ice fog common during winter in Fairbanks.

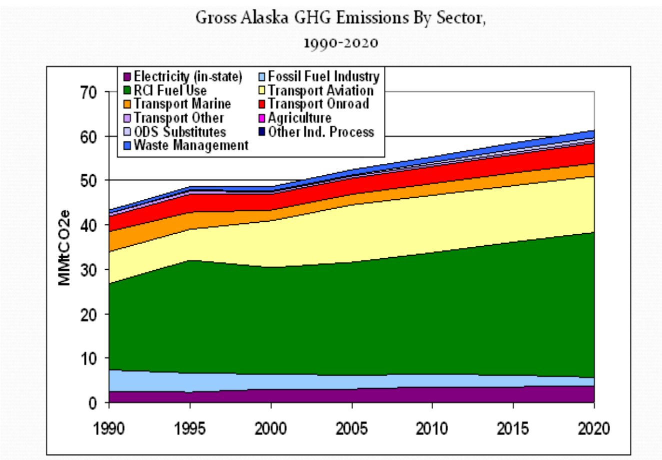
Alice Edwards, Program Manager, Air Non-Point and Mobile Sources, Division of Air Quality, Alaska Department of Environmental Conservation, Anchorage, AK: "*Air Emissions in Alaska".*

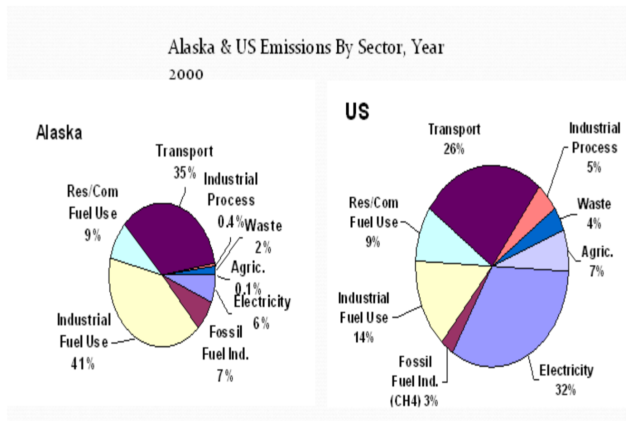
Ms. Edwards presented substantial data on emissions in Alaska, shown in Figure 9. During the summer season, forest fire emissions are a major source, as shown in Figure 10. Other sources that degrade air quality in Alaska include road dust and fuel use. Automobile emissions are regulated, while non-road emissions, such as wood burning and off-road vehicles, are not. Industrial sources in Alaska are dispersed geographically and can produce high pollutant levels in relatively unpopulated regions. There are considerable NO_x emissions from cruise ships in Juneau and Ketchikan. Major point sources of air pollution include: military installations, fish processing plants, oil and gas facilities and electrical power generation. There are large emissions of greenhouse gases from busy airports throughout Alaska

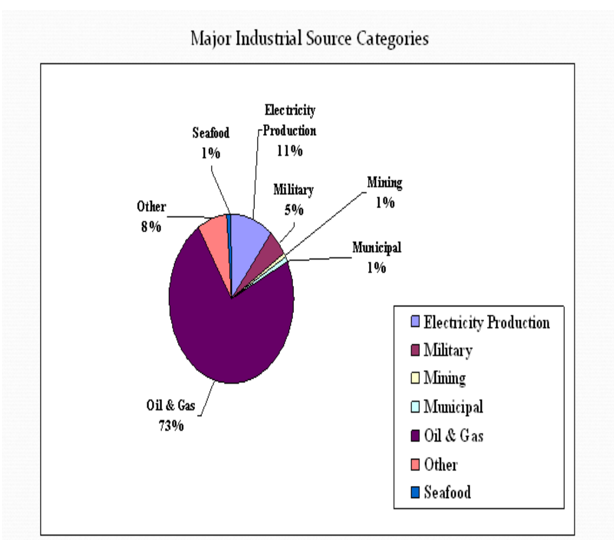
Alaska Fire Emissions - 2005

Parameter	Wildfire	WFU	Prescribed Fire	Total
Number of Fire Events	558	12	4	574
Fire Acres	4,493,846	169,956	626	4,664,428
Emissions (Tons)				
$PM_{2.5}$	1,951,420	67,344	210	2,018,974
PM_{10}	2,275,307	78,521	245	2,354,074
Elemental Carbon (EC)	121,458	4,192	13	125,662
Organic Carbon (OC)	939,273	32,415	101	971,788
SO_2	137,652	4,750	15	142,417
NO_x	502,025	17,325	54	519,404
VOC	1,101,216	38,003	119	1,139,338
CO	23,400,846	807,569	2,522	24,210,937
CH_4	1,101,216	38,003	119	1,139,338
NH_3	105,263	3,633	11	108,907









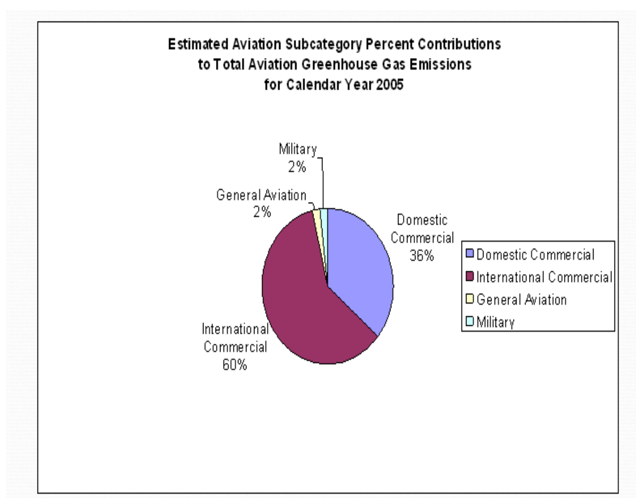


Figure 9: Emissions by Source and Sector in Alaska

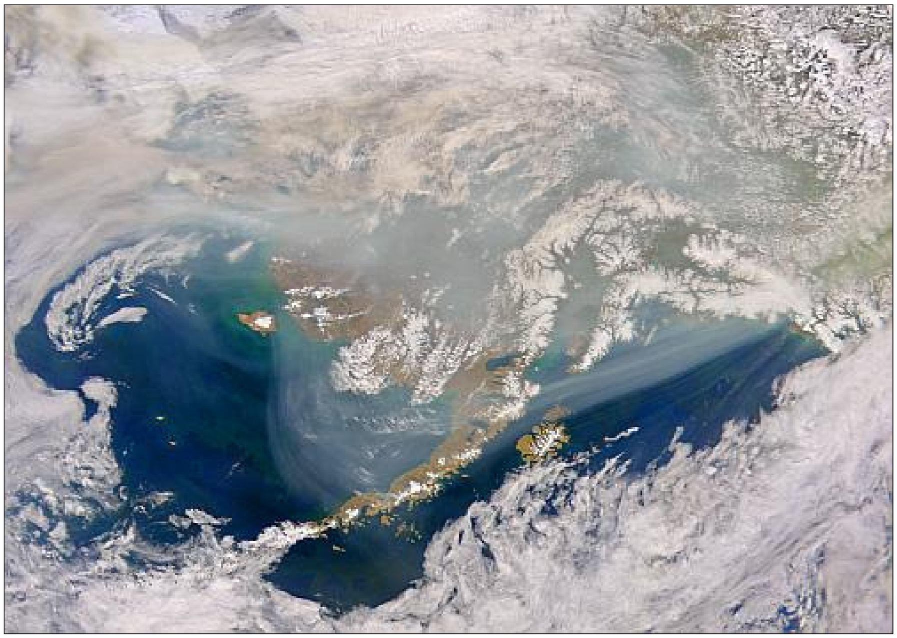


Figure 10: MODIS image of forest fire smoke over Alaska. The origin is mostly in the center of the image but smoke is evident over the Alaska Peninsula and over the North Pacific.

SESSION 3: Airborne Contaminants in Fish and Other Foods, and Human Health

Kathy Tonnessen, IAQAB member with the US National Park Service, chaired the session.

Angela Matz, US Fish and Wildlife Service, Fairbanks, AK: *"Contaminants in Salmon and Pike".*

Sampling locations for salmon in Alaska are shown in Figure 11. Salmon and pike caught in Alaska (and across the border in Canada) are generally lower in contaminants compared to fish caught in other areas. Native people in Alaska use pike and salmon as subsistence foodstuffs. They are extremely interested in knowing what potential health risks are associated with their food supply. Studies conducted to assess contaminant levels were greatly aided by the participation of subsistence consumers and tribal organizations. Indigenous fish species are an important indicator of ecosystem health. Some fish migrate thousands of kilometres and as such can be vectors for contaminant transport across borders. Public health organizations may be underestimating the benefits of essential fatty acids found in fish for child development. The need for these essential fatty acids in the diet may outweigh the risk of contamination from fish tissues.

However, it is possible to give bad advice to subsistence fishers relative to fish contamination issues when alternative food choices may not provide the needed benefits. Public health organizations need out outline the "safe" amounts and types of fish meals that subsistence communities should consume.

Subsistence hunting and gathering are very common is isolated communities in both Alaska and northern Canada. Little salmon contaminant data was collected prior to 2001 in Alaska. Public health recommendations in Alaska allow for safe consumption of large quantities of salmon without concern for contaminants. There was particular concern about toxaphene from the air being incorporated in fish tissue. Subsistence fishers eat large amounts of pike, which have been shown to have high mercury concentrations in some areas. Data support the concern related to consumption of pike that are contaminated with mercury. Women of child bearing age and children are urged not to eat large-bodied pike (i.e. over 2 feet in length). In rural villages, pike is often dried, concentrating the mercury. The State of Alaska developed a program to measure Hg concentrations in hair of women of child-bearing age. Another Alaskan program includes the distribution of posters translating into native languages that provide information on fish consumption advisories. Migratory fish transport contaminants across borders – e.g. salmon, char and whitefish.

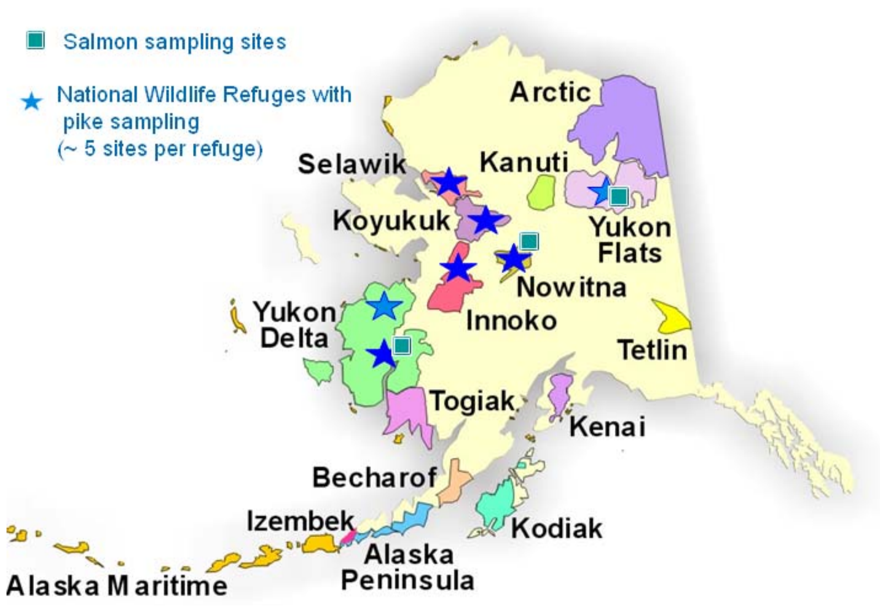


Figure 11: Location map of salmon sampling sites used by the US. Fish and Wildlife Service Environmental Contaminants Program.

Bob Gerlach, State of Alaska Veterinarian: *"Statewide Sampling of Alaska Fish".*

Fish caught in Alaska are substantially lower in pesticides, mercury and PCBs than fish caught in the contiguous United States. Large fish are generally higher in contaminants than smaller ones. Some contaminant sources are local while others are from long range transport. The source of mercury in fish is thought to be from long-range transport, but the specific sources are not known. In the State of Alaska there are three chemical groups that have formed the basis for fish consumption advisories: mercury, PCBs, and pesticides (chlordane, dioxin, DDT). Alaska has a program to test commercial and subsistence fish species for contaminants. Native runs of salmon in Alaska have low contaminant concentrations. Farmed salmon generally have much higher contaminant concentrations than wild populations. There were data collected by NOAA in 1976 on marine fish contaminants. Figure 12 shows levels of pollutants in fish compared to the FDA Action Limit. This sample was repeated in the mid-2000s and revealed a significant increase in fish tissue contamination, especially in halibut caught off the coast of Alaska by commercial fishermen. This change in concentrations may be attributed to long-range contaminant transport. Figure 13 shows an example of Asian dust moving across the Pacific Ocean.

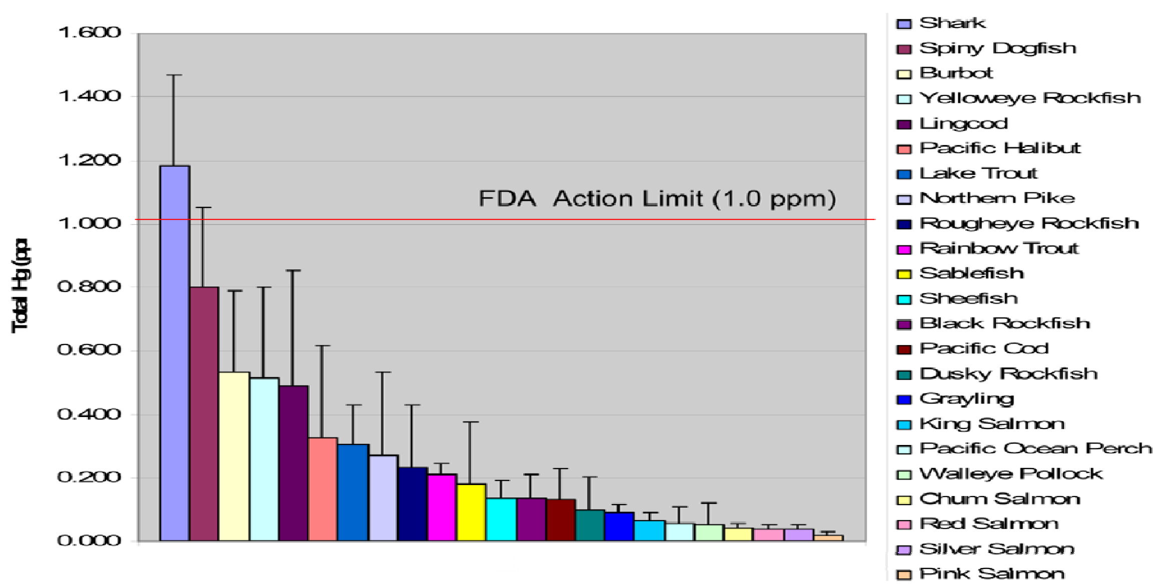


Figure 12: Concentrations of pollutants in various fish species

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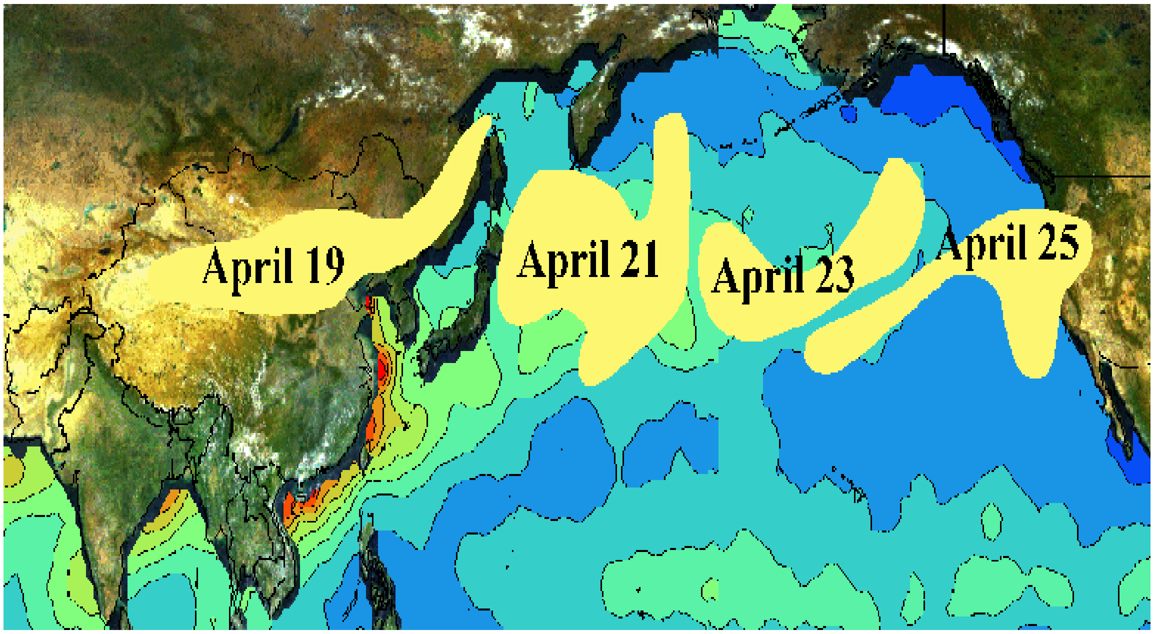

Figure 13: Asian dust cloud locations during the April 1998. The cloud originated in China and reached the west coast of the US and Canada in less than a week.

Lori Verbrugge, Department of Health and Social Services, State of Alaska: *"Human Health Issues Associated With Contaminants in Traditional Foods in Alaska".*

The State of Alaska is concerned that fish and game for subsistence consumption may contain high levels of contaminants. Fish is the most important food source for Alaskan subsistence consumers who preserve it for year round use (see Figure 14). Game constitutes the second-most important food source. In Alaska, 95% of residents eat native fish. More fish is consumed in rural communities than is recommended by the EPA. This is illustrated in Figure 15. Public health and native health professionals have developed dietary guidelines that are not necessarily in line with recommendations for consumers in urban areas, and in the lower 48 states. Replacement of native fish and game with processed often lower quality foodstuffs has a high monetary, cultural and dietary cost to these populations.

Figure 14: Traditional subsistence salmon preservation methods commonly used to process the yearly catch for year-round consumption

Sea mammals (whales, seals, walrus) are important food sources in North Slope villages (i.e. the villages Barrow, Point Hope, Wainwright, Nuiqsut, Point Lay, Kaktovik, Atqasuk and Anaktuvuk Pass). Subsistence is a way of life and public health professional encourage harvesting and consumption of local fish and mammals, since the health benefits often outweigh the risks. Obesity in North Slope villages has significantly increased due to consumption of non-traditional foods; diabetes is also on the rise. It is difficult for state regulators to sample marine mammal species to determine contaminant loads, since many of these species are protected. Researchers must work with local hunters to collect samples for chemical analysis. Safe monthly intake limits of marine mammal blubber are shown in Figure 16.

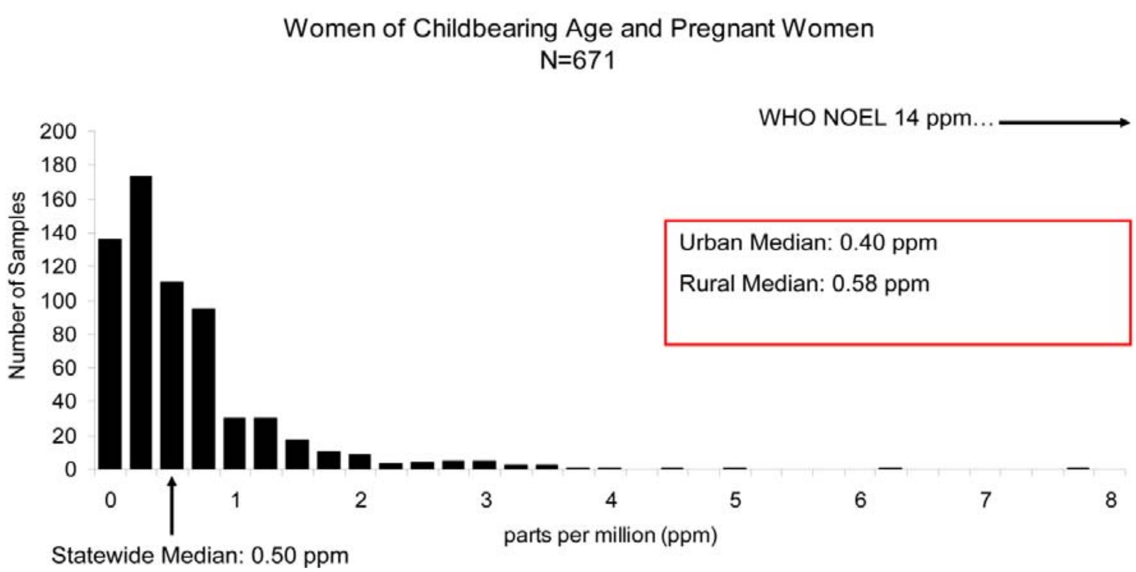

Figure 15 Alaska Statewide Hair Mercury Biomonitoring Program - Alaska, July 2002-2008

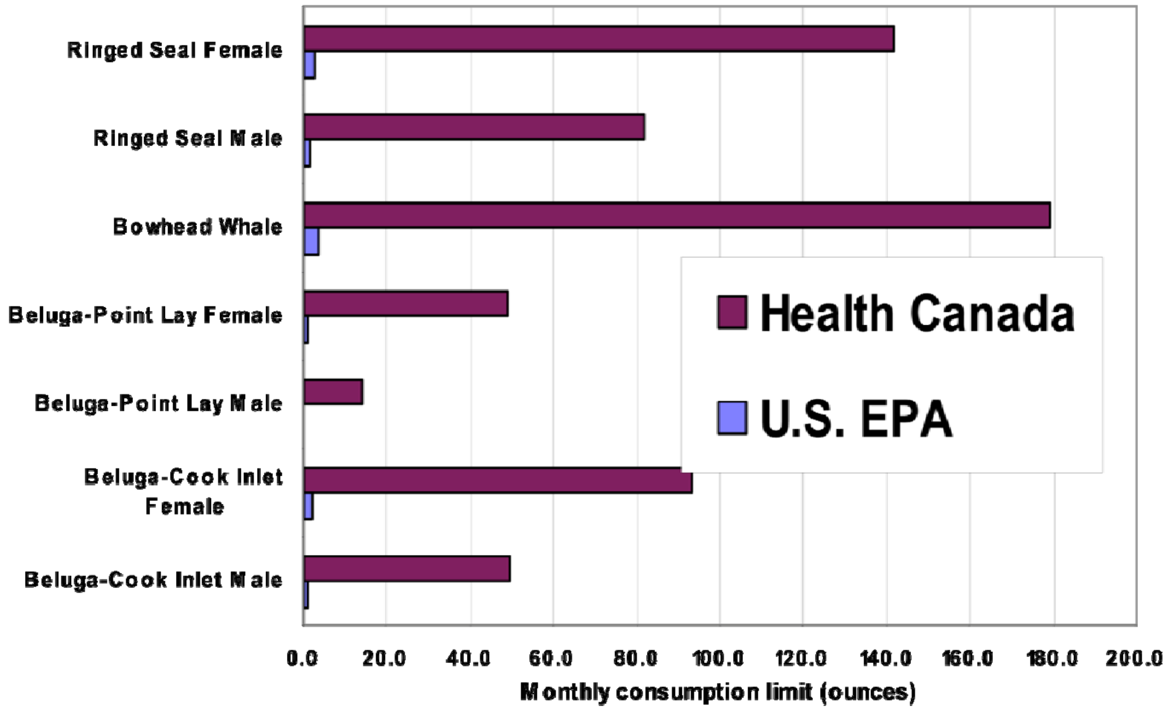

Figure 16: Safe Monthly Intake limits of Marine Mammal blubber (Based on PCBs) - Alaska, 1990s[3]

Mary Ellen Gordian, University of Alaska, Anchorage: *"Health Effects Research, Fuels and Traffic Related Air Pollution".*

Indoor air quality poses a significant health risk in Alaska, especially during the wintertime. This could be in part due to high levels in benzene in gasoline and the prevalence of heated attached garages. Other sources for poor indoor air include the use of wood for home heating, and poor ventilation in structures. Studies to monitor air quality have been difficult to conduct due to the relative unwillingness of participants to wear personal monitoring equipment. In Alaska, particulate matter below 10 microns in diameter (PM_{10}) appears to be important in asthma prevalence. PM_{10} sources include road dust, wood smoke, etc. Because of low temperatures, there is incomplete fuel combustion, resulting in emission of air pollutants to both indoor and outdoor air.

[3] Note: The reason for the differential between U.S. EPA and Health Canada is that each agency uses a different exposure limit for PCBs. EPA uses a cancer risk factor that equates to 20 ng/kg/day, while Health Canada has adopted the WHO JEFCA (Joint FAO/WHO Expert Committee on Food Additives) limit of 1 ug/kg/day. The differential between these (50x) explains the differentials in the chart. It should be noted that there are no actual limits set for maximum ingestion of country foods, but that these are based on a PCB intake limit and consumption of specific amounts of each item. Such limits do not recognize the health and cultural benefits of country foods intake, nor would these differentials necessarily be the same if based on other contaminants.

Natural sources of PM also include volcanic eruptions, such as Mount Spurr, which erupted 1992 and rained ash on Anchorage. Benzene is a major issue in urban areas, where gasoline can contain 3-5% benzene -- a volatile organic compound (VOC) and a carcinogen. All gasoline used in Alaska is refined there, with additions of MTBE to reduce the formation of carbon monoxide. In Alaska, hospital visits for asthma patients increase in spring and fall, with more visits to hospitals in Fairbanks than in Anchorage (due to inversions). Homes are super insulated and tightly sealed, and thus indoor air pollution is a significant problem. Children living near high traffic streets have 200 times to 500 times the increased risk of contracting asthma. Parking vehicles in attached home garages is a bad idea due to VOCs emissions from gasoline, with particular issues associated with high benzene concentrations in gasoline. Overall benzene concentrations in Anchorage are elevated compared to other urban areas in the lower 48 states as shown in Figure 17.

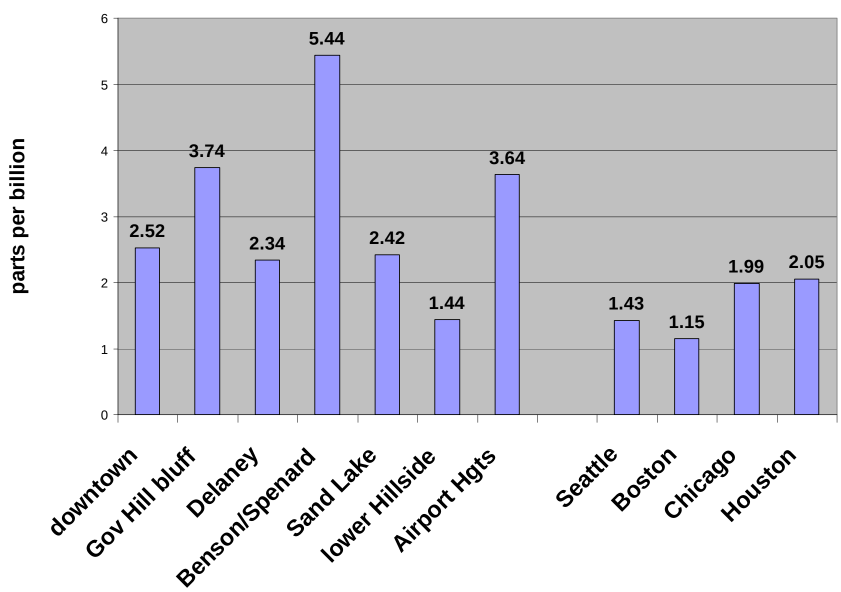

Figure 17: Benzene levels around Anchorage relative to levels in some major U.S. cities. Overall benzene levels are elevated in Anchorage.

SESSION 4: Alaska Case Studies

Randy Piercy, IAQAB member with the Province of New Brunswick, moderated.

Bud Rice, National Park Service, Alaska Regional Office, Anchorage, AK: *"Air Quality issues for the National Park Service in Alaska and the Western Airborne Contaminants Assessment Project - Results for Alaska".*

Air quality issues in Alaska national parks arise from wildfire, volcanoes, human activity, climate change effects, and long range transport. Nine percent of global sea level rise has been attributed to the melting of Alaskan glaciers. Volcanic eruptions and passive degassing can outweigh industrial emissions of certain air pollutants. Most air contaminants arrive in Alaska from long range transport across the Pacific and in the circumpolar region. However, the six-year project conducted by the National Park Service (NPS) to determine the levels of persistent organic pollutants in ecosystems indicated that Alaska had lower concentrations of all measured pollutants, when compared to parks in the western United States, including Olympic, Mount Rainier, Glacier, Rocky Mountain, Sequoia-Kings Canyon national parks. This project is known as the Western Airborne Contaminants Assessment Project (WACAP).

There are local pollution concerns in parks in Alaska. In Glacier Bay National Park and Preserve, the National Park Service (NPS) is monitoring the number of cruise ships that enter the Bay due to the levels of air emissions from these large vessels, see Figures 18 and 19. Northwest Alaska, near the Noatak National Park, is the home to the Red Dog mine, the world's largest lead and zinc mine. Deposition of contaminants from that mine have resulted in toxic responses in lichens and mosses. While air issues are important in the North, climate change is currently the most visible. Drunken forests , where trees tilt in all directions like a group of rowdy revellers stumbling along the street are become an eye-catching Alaskan roadside attraction as a result of permafrost thawing,. Similarly, as the sea ice retreats and thawing of permafrost progresses releases of mercury into the environment is being accelerated.

Daily Emissions (pounds per day)

	Daily Vessel Quota	PM	NO_x	SO_2	CO	HC
Cruise Ships	2	136.01	4,393.30	4,614.38	511.46	57.50
Tour Vessels	3	17.25	694.38	110.02	73.74	7.04
Charter Vessels	6	7.42	297.51	46.93	35.42	3.70
Private Vessels	25	70.53	2,836.98	449.15	307.51	29.93
Total		231.21	8,222.17	5,220.49	928.13	98.17

Annual Emissions (tons per calendar year)

	Annual Use Days	PM	NO_x	SO_2	CO	HC
Cruise Ships	261	8.87	286.66	301.09	33.37	3.75
Tour Vessels	520	1.50	60.18	9.54	6.39	0.61
Charter Vessels	607	0.38	15.05	2.37	1.79	0.19
Private Vessels	2,464	3.48	139.79	22.13	15.15	1.47
Total		14.23	501.68	335.13	56.70	6.02
Net Change from Existing Conditions		2.77	99.93	56.97	11.23	1.18
% Change from Existing Conditions		16%	17%	15%	17%	16%

Note:
Annual-use days include proposed seasonal-use day quotas for all vessels and May and September use day quotas for cruise ships and tour vessels. Ferry service is included in tour vessel totals. Projected off-season use days for charter and private vessels are based upon existing numbers (see chapter 3).

PM = particulate matter.
CO = carbon monoxide.
SO_2 =sulfur dioxide.
NO_x = nitrogen oxides.
HC = hydrocarbons.

TABLE 4-11: ALTERNATIVE 6 DAILY AND ANNUAL VESSEL EMISSIONS

Daily Emissions (pounds per day)

	Daily Use Quota	PM	NO_x	SO_2	CO	HC
Cruise Ships	2	147.28	1,432.00	1348.41	521.04	95.57
Tour Vessels	4	17.25	694.38	110.02	73.74	7.04
Charter Vessels	6	7.42	297.51	46.93	35.42	3.70
Private Vessels	25	70.53	2,836.98	449.15	307.51	29.93
Total		242.48	5,260.87	1,954.51	937.71	136.24

Annual Emissions (tons per calendar year)

	Annual	PM	NO_x	SO_2	CO	HC
Cruise Ships	231	8.51	82.70	103.15	30.09	5.52
Tour Vessels	520	1.50	60.18	9.54	6.39	0.61
Charter Vessels	607	0.38	15.05	2.37	1.79	0.19
Private Vessels	2,464	3.48	139.79	22.13	15.15	1.47
Total		16.61	324.57	137.19	63.19	9.58
Net Change from Existing Conditions		5.16	-77.19	-140.97	17.72	4.74
% Change from Existing Conditions		45%	-19%	-51%	39%	98%

Note:
Annual use days include proposed seasonal-use day quotas for all vessels and May and September use day quotas for cruise ships and tour vessels. Projected off-season use days for charter and private vessels are based upon existing numbers (see chapter 3)

PM = particulate matter
CO = carbon monoxide
SO_2 = sulfur dioxide
NO_x = nitrogen oxides
HC = hydrocarbons

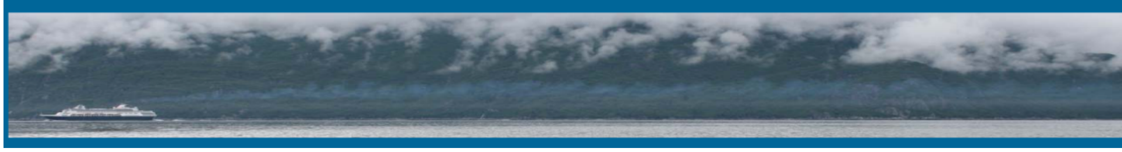

Figure 18: Emissions Data for Cruise Ship in Glacier Bay - NPS 2003 Data for Vessel Quotas and Operating Requirements EIS, Glacier Bay, Alaska

Figure 19: Cruise ships are a common sight in Alaskan coastal waters. Emissions from these ships affect air quality in national parks, some of the very resources cruise ship companies use to attract customers.

Andrea Blakesley, National Park Service, Denali National Park and Preserve: *"Long Term Air Quality Monitoring in Denali National Park and Preserve".*

National Park Service air quality monitoring sites are an important resource for interagency and regional assessments of the status of air quality, especially in Class 1 areas, see Figure 20. These monitoring sites become a focus for short-term research projects, initiated by the NPS and by other researchers. Denali National Park and Preserve has some of the cleanest air in North America, but some contaminants have been detected. Forest fire smoke comes from local sources in Alaska but also from long range transport from Canada and Russia. Seasonal changes in Arctic haze indicate there is some international and local contribution to background pollution. National parks provide data on "background" air quality conditions and serve as venues to educate the public on air pollutants and their effects. NPS has its own air quality monitoring network. The site at Denali National Park has operated for 28 years and monitors visibility, wet and dry deposition, ozone concentrations and climate variables.

Figure 20: Air Quality monitoring installation at Denali National Park and Preserve. This site serves a dual role as a permanent air quality monitoring site and a place for other short term air quality studies.

Melissa Pfeffer and Kristi Wallace, US Geological Survey, Alaska Volcano Observatory, Anchorage, AK*: "Contributions to the Atmosphere from Volcanic Eruptions".*

Volcanoes are an important source of fine particulate pollution during eruptions (Figure 21). During quiet, noneruptive intervals, volcanoes contribute a significant amount of pollution by passive degassing. Some of the effects of volcanic ash and gases are local, while long range transport of these pollutants can have hemispheric effects on climate, health and ecosystems. Monitoring volcanoes helps to predict eruptions. Ash fall forecasts are aided by air transport models which show possible impact areas. These forecasts can be used by local planners to form an appropriate eruption response, especially to protect human health and aviation. There are about 130 volcanoes in Aleutian Arc, about half have erupted in last 10,000 years and are therefore considered to be "active". Approximately 30,000 people a day fly over this area on intercontinental flights. Some volcanoes, such as Mount St. Helens, have produced 4-7% very fine particulates (glass). In Alaska, the source of information on eruptions and ash falls is the analysis of lake cores which record up to 70 separate events. These volcanic emissions often move across the border into Canada (Figure 22).

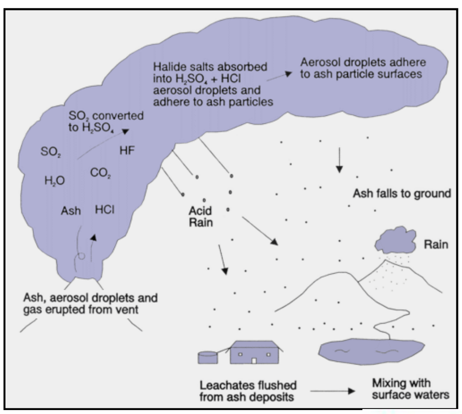

Figure 21: Diagram of volcanic emissions sources, sinks and atmospheric processes. Many volcanic gases are emitted passively, while ash is produced during eruptions.

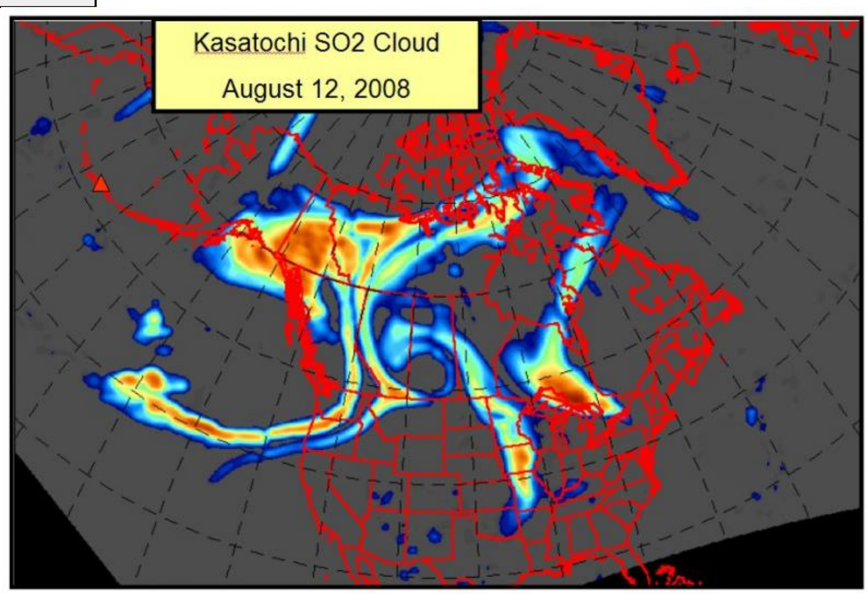

Figure 22: This map shows the extent of the sulfur dioxide cloud from the 2008 eruption of the remote Kasatochi volcano on August 12, 2008.

Workshop wrap-up: Ann McMillan and Gary Foley, co-Chairs, IAQAB.

The Chairs indicated that the results of this meeting and recommendations for future activities will be summarized and then presented to the IJC Commissioners. They also 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. Do we need to plan another meeting in a year?

The Chairs also briefly discussed international monitoring activities that could be linked to future work:

- 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.

- In the United States the Global Earth Observation System of Systems (GEOSS) lead agency is the Environmental Protection Agency, see website at http://www.epa.gov/geoss/. The purpose of GEOSS is for the world community to share environmental monitoring data to allow for better decision making to enhance societal benefits, based on knowledge of environmental trends, globally. Data are limited to observations for model inputs. GEOSS tries to address the spectrum of users, including researchers and earth system service providers to determine what sort of data is needed for observations. GEOSS also strives to determine the information and data needs, user applications, user objectives, and how best GEOSS can meet these needs. The GEOSS work plan spans 2007-2009, coincident with the International Polar Year. GEOSS works by advocating sustained observing systems and user engagement.

Workshop Conclusions

1. The IAQAB and IJC representatives were pleased to have the great opportunity to meet Alaskan and western Canadian air quality experts in such an informative setting. Much good information was exchanged.

2. They wanted to get feedback from this group on how to continue the dialogue started in Anchorage and discussed the possibility of a meeting in Whitehorse and/or British Columbia to explore more of the issues associated with the border region shared by southeast Alaska and northern British Columbia and the Yukon.

3. The International Joint Commission was briefed on the outcomes of the consultation and work continued to refine the results coming forward through a series of calls and an internet-based seminar.

4. The workshop results were summarized subsequently in a series of recommendations presented in the Executive Summary.

5. The IAQAB continues to foster the need for future exchanges along the Northern border.

Appendices

AGENDA

Welcome and Introductions: *Ann McMillan, Canadian Co-Chair IAQAB, Gary Foley, US Co-Chair IAQAB*

International Joint Commission
Commissioners Allen Olson

National Park Service, Anchorage, Alaska
John Quinley, Assistant Regional Director

IAQAB Overview *Ann McMillan, Canadian Co-Chair IAQAB Gary Foley, US Co-Chair IAQAB*

Session I: Long Range Transport of Contaminants and Possible Sources *Moderator – Harold Garabedian*

Cathy Cahill, University of Alaska, *Sources and Transport of Aerosols in the Arctic*
Carven Scott, NOAA, and **Martin Stuefer**, *A new WRF/Chem Wildfire Smoke Forecast System for Alaska*

Brian Wiens Research Scientist, Air Quality Modelling Applications, Meteorological Service of Canada, Canadian Forest Fire Smoke Forecasting

Dave Fox, Air Pollution Management Analyst, North; Environment Canada, *Air Issues in Northern Canada*

Dan Jaffe, University of Washington, *Global Transport of Mercury, Ozone and PM: Policy Relevant Results*

Haley Hung Research Scientist, Process Research, Environment Canada, Trends of Atmospheric Transport of Organic Pollutants to the Arctic

Session II: Monitoring Air Contaminants *Moderator – Rick Artz*

Barbara Trost, Program Manager, Air Quality and Quality Assurance, Division of Air Quality, Alaska Department of Environmental Conservation, Anchorage, *Air Quality Monitoring in Alaska*

Alice Edwards, Program Manager, Air Non-Point & Mobile Sources, Division of Air Quality, Alaska Department of Environmental Conservation, Anchorage, *Air Emissions in Alaska*

Session III: Airborne Contaminants in Fish and Other Foods and Human Health Considerations *Moderator – Kathy Tonnessen*

Angela Matz, US Fish and Wildlife Service, Fairbanks, *Contaminants in Salmon and Pike in Alaska; A Subsistence Perspective*

Robert Gerlach, State of Alaska, *Fish Tissue Monitoring Program*

Lori Verbrugge, Department of Health and Social Services, State of Alaska, *Human Health Issues Associated with Contaminants in Traditional Foods in Alaska*

Mary Ellen Gordian, University of Alaska, *Air Pollution, Traffic, and Health Effects Research, What has been done in Alaska*

Session IV: Alaska Case Studies *Moderator – Randy Piercey*

Bud Rice, National Park Service, *Air Quality Issues for the NPS in Alaska & Western Air Contaminants Assessment Project Results for Alaska*

Andrea Blakesley, National Park Service, *Long-Term Air Quality Monitoring in Denali National Park*

Melissa Pfeffer, Kristi Wallace, and Cindy Werner USGS, Alaska Volcano Observatory, *Contributions to the atmosphere from volcanic eruptions in Alaska*

Adjournment and Wrap- up, *Ann McMillan, Canadian co-Chair IAQAB, Gary Foley, US co-Chair IAQAB*

List of Attendees - Anchorage Alaska Expert Consultation, September 2008

Alley	Doug	International Joint Commission
Artz	Richard	IAQAB
Blakesley	Andrea	National Park Service
Breuninger	Anna	Alaska Department of Environmental Conservation
Cahill	Cathy	University of Alaska
Darnell	Joan B.	National Park Service
Dettmer Shea	Cindy	Alaska Department of Environmental Conservation
Edwards	Alice	Alaska Department of Environmental Conservation
Foley	Gary	US Co-Chair IAQAB
Fox	Dave	Environment Canada
Garabedian	Harold	IAQAB
Gerlach	Robert	Alaska Department of Environmental Conservation
Gordian	Mary Ellen	University of Alaska
Gouin	Todd	University of Alaska
Holderied	Kris	NOAA
Hung	Hayley	Environment Canada
Jaffe	Dan	University of Washington
Johnson	Philip	US Fish and Wildlife Service
Lawler	Jim	National Park Service
Matz	Angela	US Fish and Wildlife Service
McMillan	Ann	Canadian Co-Chair IAQAB
Miller	Amy	National Park Service
Moore	Claudette	National Park Service
Nelson	James	NOAA/NWS
Olson	Allen	International Joint Commission
Pfeffer	Melissa	USGS/AVO
Piercey	Randy	IAQAB
Quinley	John	National Park Service
Rice	Bud	National Park Service
Rinkleff	Peter	University of Alaska
Ryan	Kristin	Alaska Department of Environmental Conservation
Schirokauer	Dave	National Park Service
Schreiner	Irma	UAA/ISER
Scott	Carven	NOAA
Shearer	Jeff	National Park Service
Shephard	Michael	National Park Service
Teas	Howard	State of Alaska
Tonnessen	Kathy Ann	IAQAB
Trost	Barbara	Alaska Department of Environmental Conservation
Verbrugge	Lori	Department of Health and Social Services
Vimont	John	Chief of NPS Air Resources Research and Monitoring
Wallace	Kristi	USGS/AVO
Warthan	Dan	National Park Service
Weiner	Joel	International Joint Commission
Wiens	Brian	Environment Canada, PNR