

# AMAP report to the meeting of Senior Arctic Officials, Narvik, November 28-29, 2007.

## Prepared by the AMAP Board.

2007-11

### Arctic Monitoring and Assessment Programme (AMAP)

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**1. Status of Oil and Gas Assessment**

**a. Timeline and Funding**

As previously reported to SAOs, the delivery of this assessment has been delayed as a result of late delivery of promised (national) contributions that are critical to completing the assessment. However, we are pleased to report that the assessment is now completed.

Authors of the scientific assessment are currently finalizing work on their chapters to ensure that updated drafts of all substantive scientific chapters will be available by the time of the Narvik SAOs meeting. These drafts will be complete in terms of content, although in most cases the chapters still need to be subject to final technical and linguistic editing that may include some restructuring of information. The authors have also agreed a draft of chapter 7 of the scientific assessment that includes scientific recommendations that are reflected in the Executive Summary to the Overview report. Drafts of these chapters will be made available on a password protected part of the AMAP website in advance of the Narvik SAO meeting. The lead authors of the scientific assessment have also reviewed the content of the overview report to confirm that this report accurately reflects the science that is presented in the scientific assessment report.

The results of the assessment will be presented to the SAOs at their meeting in Narvik; this presentation will cover the key findings and conclusions of the scientific assessment, the final draft of Overview report and its Executive Summary including Recommendations that have been reviewed by the AMAP WG based on national input and input from some PPs.

The remaining deficit in the revised budget for the production is planned to be covered by subscription by the Arctic countries and other stakeholders for copies of the reports, to be delivered at cost price. Countries and organizations have been asked to submit pre-orders for numbers of copies of the reports they would like to receive. Some countries have unfortunately not yet responded.

The overview report is currently in production and will be available in print early in 2008. The scientific report will appear in print in two or three volumes that will be released as soon as the necessary production work can be completed; this will also ensure that material can be made available without a need to await final work on the last chapters. The first volume is expected to be available in print during the first half of 2008

**Presentation options**

A plan for external release of the results of the scientific assessment was presented to the SAOs at their meeting in April, reflecting the decisions made at the AMAP WG meeting in Hanover, USA. This is further described in material provided to SAOs for consideration at the Narvik meeting. The first release of the results of the oil and gas assessment is planned for the Arctic Frontiers Conference (Tromsø, January 2008), with

this activity being repeated at other relevant events in North America (the Alaska Forum on the Environment in Anchorage, February 2008) and Russia (the Russian Offshore 2008 meeting in Moscow, February 2008).

## **2. Deliverables to 2009 Ministerial**

### **a. Updated assessment on mercury in the Arctic**

The AMAP mercury expert group met (in Copenhagen, 29-31 October) to initiate the work on a planned update assessment on mercury and develop a timetable for delivery of this update assessment in 2011 – working on the assumption that that the Ministerial meeting schedule will be altered and a meeting held in spring 2011 rather than fall 2010. This assessment will incorporate the considerable amount of new information on this subject that has arisen since the last assessment in 2002. The results of this assessment will therefore now be considered by the AMAP WG in 2010 rather than 2009.

Taking into account mercury assessment activities currently ongoing under UNEP (to produce a report on atmospheric emissions and transport as requested by the UNEP Governing Council) and the UN ECE (where their group working on Hemispheric Transport of Air Pollutants are conducting an assessment of atmospheric transport of mercury), the AMAP WG have asked the expert group to consider possibilities to deliver specific components (e.g. updated information on emissions) already in 2008/2009. AMAP and UNEP-Chemicals have been engaged in consultation to ensure that, to the extent possible, work on their respective Arctic and global assessment activities is well-coordinated, that experts are involved in a cost-efficient manner, and that the result of these assessments are compatible. The response of Denmark, Norway, and Sweden in particular to requests for funding to support the involvement of experts that will contribute to both the AMAP and UNEP activities is much appreciated.

### **b. Updated assessment on POPs in the Arctic**

The AMAP POPs expert group has developed an assessment timetable whereby they plan to produce scientific ‘review articles’ (and related fact sheets) on seven topics:

- brominated flame retardants (new information);
- per- and polyfluorinated compounds;
- polychlorinated naphthalenes
- endosulfan;
- current use pesticides;
- effects of POPs;
- dynamics and processes important for transport and accumulation of POPs in the Arctic, use of modeling, and emission estimates for old and new contaminants.

These products will be produced during 2007 and 2008 with a view to joint publication by AMAP and an appropriate scientific journal. Based on these products, and through a

series of drafting meetings, a science writer would be engaged to produce a new summary report during 2008 for delivery to Ministers in 2009.

The expert group also plan to prepare data products, in particular products on trends (for both legacy POPs and new POPs) to support work under the UN ECE and UNEP (Stockholm Convention). A trend assessment workshop, similar to that conducted for mercury in 2006, is being planned for early 2008, utilising a statistical toolkit that has been specially developed for AMAP.

A separate workshop on effects of POPs is being arranged in Copenhagen in January 2008 that will contribute to the parts of the planned work on effects of POPs, and also coordinate this work with related IPY activities.

#### **c. Updated assessment on human health issues in the Arctic**

The AMAP human health expert group is currently working on an update assessment on human health in the Arctic that is planned for delivery at the Ministerial meeting in 2009. The group will meet last week of November to prepare the next draft that will be circulated for internal review first half of 2008. A science writer is planned to be engaged to produce a related overview report. A Symposium in autumn 2008, linked to the IPY, is under preparation together with other international partners.

AMAP and SDWG is working together to improve and synchronize health related activities within the Arctic Council. The plan is to finish the preparation of a strategy paper during spring 2008.

#### **d. Updated assessment on radioactivity in the Arctic**

The AMAP radioactivity expert group is under way with the assessment of radioactivity in the Arctic including reassessment of sources and re-evaluation of actions. This is a timely assessment since several international organizations have requested an evaluation of the current situation. This will be a topic oriented report that in will include results from monitoring, protection of the environment (including an assessment tool), the issue of technology enhanced natural technology radioactive material it's sources (including result from oil and gas activity) and it's consequences, and finally the topic of combined effects from radioactive contamination with other contaminants is addressed. A number of ongoing projects are contributing to the 2009 assessments. The first draft will be available for the radioactivity group in December 2007. The plan is to deliver the full report to the AC in 2009.

### **3. Follow-up to ACIA**

#### **The Arctic Council Cryosphere project**

AMAP has since June taken over the preparation of this project. Over the summer a draft proposal has been prepared by experts from the Arctic countries in close cooperation with international organization, especially IASC, CliC and IPY. A special report including all

details for the proposed project has been presented to the SAOs. There are some important outstanding questions related to this project, especially commitment to take the lead of some of the sub-projects and we hope this can be resolved by the time of the SAO meeting.

### **Arctic carbon cycle assessment**

Based on the Arctic Carbon Flux workshop held in Seattle (February 27-28), co-sponsored by AMAP, IASC and CliC, A Scientific paper is under preparation that includes present knowledge and gaps in knowledge. A draft paper is planned for mid November 2007 and the publication will hopefully be out in 2008. The activity is linked to global work on Carbon Flux and Climate Change.

### **Downscaling from global to regional climate models**

AMAP organized a workshop on (statistical) downscaling of modelling in Oslo (May 14-16). A report from the workshop has been prepared and is ready to be circulated, including:

- summarizing the present status concerning statistical downscaling and adjustment techniques;
- showing examples where statistically downscaled or adjusted climate descriptions and/or scenarios have been applied in local impact studies;
- outlining possible projects including downscaling of climate scenarios for a few selected key areas in the Arctic, as well as application of these scenarios in selected pilot impact studies; and
- discussing cooperation with non-Arctic downscaling initiatives.

The participants were very pleased with the outcome and follow up work includes use of the methodology in IPY projects and a follow up workshop is under preparation.

### **Synthesis and analysis of IPCC 4 models and reports**

The AMAP HODs decided at their meeting in September that a preparation of a synthesize document highlighting Arctic information report from the IPCC reports would not be done since most of the information already had been presented in ACIA. Resources should be spent on the new projects.

A group of modellers in the Climate Expert Group will within the next 6 months prepare model outputs from the best Arctic models that shall be used by the Cryosphere project.

### **Short-Lived Arctic Climate Agents**

At the CEG meeting in Copenhagen it was decided to prepare a short discussion paper of the “non CO2” drivers related to Arctic Climate change. Attached is a short paper on this issue (Annex xx). An update will be given at the SAO meeting based on the outcome of a

workshop to be held in Oslo 7-8 November. For discussion under a special agenda item at the SAO meeting.

### **Unmanned Aircraft for Environmental Monitoring**

At the CEG meeting in Copenhagen representative from US-NOAA presented a paper regarding the use of Unmanned Aircraft Systems (UAS) for environmental monitoring, see Annex xy. Most Arctic countries have initiated work to use UAS. The paper calls on a international assistance from AMAP and WMO to prepare for an agreement on critical issues related to the use of this tool for research and monitoring of climate, biodiversity, pollution, etc. The use of UAS is an interesting tool related to the work under SAON. For discussion under a special agenda item at the SAO meeting.

## **4. Sustaining Arctic Observing Networks (SAON)**

At the 2006 Arctic Council Ministerial Meeting, Ministers urged all Member countries to maintain and extend long term monitoring of change in all parts of the Arctic. Furthermore, they requested AMAP to cooperate with other AC Working Groups, IASC and other partners in efforts to create a coordinated Arctic Observing network that meets identified societal needs.

Initial discussions within a 'SAON Initiating Group' (including AC/AMAP, AOSB, CliC/WMO, IASC, IASSA, IPY and NSF) were held in Tromsø in January, 2007. The 'SAON Initiating Group' (SAON IG) has been expanded to include representatives of FARO, GOOS, IPS and ISAC.

The SAON IG has defined its purpose as *'to develop a set of recommendations on how to achieve long-term Arctic-wide observing activities that provide free, open and timely access to high quality data that will realise pan-Arctic and global value-added services and provide societal benefits'*.

These recommendations will be developed through a series of workshops. The first one was held 12-14 November, 2007 in Stockholm, Sweden focussing on user needs (governmental, science, local) and through break-out groups initiating coordination between ongoing and planned observing networks.

The second workshop will be held in Alberta, Canada in spring 2008, and a third workshop in Helsinki, Finland in late autumn of 2008. The Helsinki workshop is expected to be the synthesis workshop, which then will form the basis for the set of recommendations mentioned in the purpose above.

A report from the Stockholm workshop will be presented at the SAO meeting in Narvik.

## **5. Collaboration with Arctic Council WGs**

### **a. Collaboration with CAFF on Coordinated Monitoring Effort**

At the joint AMAP HODs CAFF RAPs meeting in Copenhagen, September 18, the 'Green-paper' on future cooperation that was jointly developed by AMAP and CAFF was approved.

Linked to this paper, criteria have been developed for identification of pilot projects suitable for inclusion under this cooperation. A number of specific projects have been proposed for inclusion in the programme. The Green-paper and examples of proposed pilot projects will be presented to the SAOs as a joint AMAP-CAFF presentation.

As part of the collaboration between AMAP and CAFF, CAFF and other relevant WGs have been encouraged to make use of the Project Directory that was originally established to support the work of AMAP but which now includes information on over 600 Arctic research and monitoring projects and programmes, many of which are related to CAFF activities. This online project directory can be found at: <http://www.amap.no/Resources/ProjectDirectory.htm>.

### **b. Collaboration with SDWG**

An activity has been initiated to try to better coordinate human health activities being initiated under AMAP, SDWG and also IPY. Meetings have been arranged to discuss strategies for future coordination, both within the Arctic Council and with other relevant international organizations, e.g. Barents Council, Northern Dimension, WHO and IUCH. A strategy paper is under development.

### **c. Collaboration with ACAP**

AMAP has noted that ACAP projects to date have focussed very much on Russia; the ACAP mercury and BFR projects reflect the need for ACAP to a greater extent to address pollution sources in other countries to a greater extent (including sources in non-Arctic areas of Arctic countries).

### **d. Collaboration with PAME**

The development of the Norwegian led initiative (involving both SDWG and PAME) concerning a 'Project on Implementation of Integrated, Ecosystems-based Oceans Management in the Arctic' was discussed by the AMAP WG. The AMAP Chair was requested to discuss with the Chairs of PAME and SDWG the need for greater consultation on planned initiatives that were likely to involve overlap with AMAP.

### **e. Collaboration with EPPR**

AMAP and EPPR have been engaged in cooperation on mapping/GIS initiatives during recent years. A plan is under development to extend this cooperation to involve other AC WGs. There is an intention to hold a workshop on online-mapping/GIS initiatives during the winter of 2008 that will also hopefully involve a number of other groups that are engaged in related activities and/or have provided data or assisted AMAP in GIS activities to date. One important task for such a workshop will be to consider the scope and purposes of future possible activities to make AC information available through online mapping solutions.

## 6. Collaboration with IPY activities

IPY is creating an influx of new knowledge and data on the Arctic both as to the Arctic natural environment, societies and local peoples. Projects related to contaminants, climate change and human health are particularly relevant for AMAP.

AMAP has a close dialogue with the International Programme Office of the IPO, and a general agreement on securing data availability for future AMAP assessments. The dilemma so far is that the IPY data management plan; e.g. where the various data sets will be archived is not finalized. However, this problem is expected to be solved in some months.

Another strategy is to link directly to relevant projects. For instance the AC Cryosphere project can benefit considerably by collaboration with related IPY projects (and vice versa). At the meeting of the IPY Joint Committee (the international steering committee of IPY), the current AC projects were briefly presented by the AC observer, and there was a positive response to forming links as mentioned.

## 7. Status of developing projects in Russia

The proposed **Siberian Hydrology project** that has received considerable interest from within the GEF organizations (UNEP and UNDP) has now been put on track again. An application to GEF UNEP will be provided by Russia in cooperation with AMAP by the end of December 2007. The project is part of the follow-up to the Lena River project and ACIA. RAIPON will be involved in the Siberian Hydrology project. This project can be a major contributor to the Arctic Council Cryosphere project.

The UNEP review of the **PTS** project was very favourable. Russia has set aside financial resources to follow up this project and an application to UNEP GEF for financial support under preparation by Russian authorities, hospitals and laboratories and AMAP. The proposal will be prepared by end of December 2007.

During early September there was an expedition to **Franz Josef Land** that implemented a field project to document the size of the contamination and look at possible clean up strategies for the areas. Russia has allocated some 300.000 USD for this work and NEFCO has allocated 200.000 Euro. A report will be prepared.

Based on funding from Norway the **mercury monitoring** at Amderma has been continued through 2007, but funds are now required to prolong this monitoring activity. In connection with IPY some POPs instruments will be in operation in Northern Russia based on funding from Canada. The upgrade of the Tixi station has continued partly based on funding from the US. Several countries have expressed interest in installing instruments at this station. Funding is sought to secure the more long term observations and research of climate and contaminants at Arctic stations in Russia.



## **8. International cooperation:**

### **UNEP Chemicals – Mercury Assessment**

In connection with the preparation of the AMAP Update Assessment on Mercury in the Arctic (due to be delivered in 2011), parallel work to prepare mercury assessments under other international bodies including UNEP and the UN ECE has been taken into account. At the request of the UNEP Governing Council, UNEP-Chemicals will develop a global report on mercury emissions to the atmosphere in 2008. The UNECE group on Hemispheric Transport of Air Pollution are planning to include mercury in an assessment activity of hemispheric transport of pollutants that they are preparing for 2009.

The AMAP Working Group has undertaken work to ensure that relevant mercury experts from the Arctic countries are involved in these respective initiatives in a coordinated and efficient manner, including fast-tracking parts of the work on the AMAP mercury assessment to feed information into the UNEP and UN ECE processes. In particular, these concerns planned work by AMAP to produce an updated (global) inventory of anthropogenic mercury emissions to the atmosphere (also including some scenarios for future emissions); these products are required for atmospheric transport modelling. An agreement has been reached with UNEP-Chemicals that will secure the preparation of certain components of the planned (AMAP and UNEP) assessments in a manner that is efficient in terms of cost (by avoiding duplication of effort) and will enhance the quality of the products for both organizations. The work is jointly sponsored by UNEP-Chemicals, Nordic Council of Ministers, and some of the Arctic countries, including Denmark, Norway and Sweden.

### **Stockholm convention – first effectiveness evaluation**

At the third meeting of the Conference of the Parties of the Stockholm convention adopted a global monitoring plan and that first effectiveness evaluation should take part by 2009. The monitoring plan covers monitoring of air and humans – blood and milk. The monitoring and assessment work performed by AMAP is viewed by the Stockholm convention as an essential contribution to the two of the Regional assessments that cover Arctic and Northern territories. The AMAP Assessments on human health and Trends of POPs in the Environment that are under preparation will provide essential information to these two regional assessments and the global summary to be prepared. Experts from the AMAP network will assist the Stockholm convention in its work to implement the first effectiveness evaluation.

## **9. Other issues**

AMAP continues to operate thematic data centres (TDCs) to compile and archive monitoring data on contaminants in atmospheric media (at the Norwegian Institute for Air Research - , Norway); marine media (at the International Council for the Exploration of the Sea - ICES, Denmark); freshwater/terrestrial media (at the University of Alaska-Fairbanks - UAF, Alaska, USA); and data on radionuclides in the environment (at the Norwegian Radiation Protection Authority - NRPA, Norway). Current activities include a

work involving AMAP, UAF, ICES and the National Environmental Research Institute (NERI) in Denmark, to improve the systems for reporting marine data to ICES. This work, which will benefit all countries reporting marine monitoring data, is being jointly supported by Denmark and Norway. AMAP TDCs are also being proposed for use in compiling relevant IPY project data, in particular data from IPY projects focussing on contaminants.

The AMAP Project directory (<http://www.amap.no/Resources/ProjectDirectory.htm>) currently registers information on 639 monitoring and research projects and programmes concerned with Arctic environmental issues. This user-maintained online system has recently been upgraded to run on new server systems implemented at the host site. As mentioned (see cooperation with CAFF), this system is also available for use by other AC Working Groups to support their activities.

AMAP National Implementation Plan (NIP) updates and reports on implementation of AMAP NIPs have been received from several countries. All AMAP NIPs are available as electronic documents on the AMAP website ([www.amap.no](http://www.amap.no) > Publications Online > National Implementation Plans) and/or through registrations of projects/programmes in the AMAP Project Directory.

## **Annex 1. Short-Lived Arctic Climate Agents; A Possible AMAP Project**

Prepared by Dr. Drew Shindell for the  
AMAP Climate Expert Group, Copenhagen

### **Background:**

With temperature increases twice the global average, no region in the world is warming faster than the Arctic. Ice cover measurements show rapid changes in summer melt. On Greenland, melt season is beginning earlier and lasting longer. In mid-September, large areas of Arctic sea ice were only one meter thick, about 50 percent thinner than they were in the year 2001. Arctic sea ice extent has been decreasing since 1979 and shrunk to record lows earlier this fall. This can occur quickly because as sea ice melts, its reflective surface transforms into darker water, which absorbs even more heat. The famed Northwest Passage was ice free and “navigable” for the first time since satellite records began in 1978, and probably for the first time in much longer. Iceberg discharge has increased markedly as well over the past 15 years.

On the global scale, increased freshwater discharge from Greenland ice sheets so far has had only a modest impact on the present rate of sea level rise. However, the newly released IPCC projections of up to 0.58 meter rise in sea level by the end of the century did not include deterioration of Greenland ice sheets, because available models could not yet capture ice sheet dynamics. As a result, IPCC projections show only what will happen if there is little change to Greenland ice sheets this century. Today, many mainstream scientists are convinced that we are quickly approaching the point of runaway melting, with enormous implications for the unique Arctic environment, fauna and peoples; and extending its reach beyond the Arctic through sea level rise and potential shifts in the ocean currents.

Can the increasing rate of Arctic ice melting be slowed? Much of the ongoing changes in the Arctic climate remain a direct consequence of the increasing levels of long-lived greenhouse gases. With atmospheric CO<sub>2</sub>'s long lifetime (up to 25% remaining after 500 years), there will be continued warming and ice sheet melting in the future, even if all CO<sub>2</sub> emissions could be shut off today, reinforcing an urgent need for carbon dioxide reductions.

At the same time, important research in the Arctic points to a key, Arctic-specific difference: that the unexpectedly-rapid rates of current melting arise in part – and potentially, more than 50% -- from short-lived climate agents such as soot, methane and other air pollution; and that addressing those agents through rapid international action may slow current rates of melting. This, in parallel with large reductions in CO<sub>2</sub>, would buy time not only for Arctic inhabitants, but for the globe as a whole.

## Current Findings:

Major research findings on non-CO<sub>2</sub> pollutants with substantial Arctic-specific warming impact thus far include the following:

- **Black carbon** (dark particulates that arise from sources such as diesel engines and field burning or industrial plants and migrate northwards) deposit on snow and ice and absorb more of the sun's energy and warmth than an icy, white surface that reflects sunlight. Such deposition, by warming the air above the ground surface and contributing to snow and ice melting, plays a particularly important role in Arctic climate change: one research study, published June 6 in the *Journal of Geophysical Research*, estimated its impact from a minimum 31% to potentially as high as 94% of Arctic warming over the past two centuries. One of the paper's co-authors, Dr. Charles Zender, testified before a U.S. House Committee in mid October that cutting black carbon "is the most effective way we know to retard Arctic warming."
- **Aerosols** (black carbon, organic carbon, sulfates, nitrates) from a variety of industrial and mobile sources in the winter make Arctic clouds a better insulating blanket, constraining surface heat escape into space (the "Arctic haze" effect). Any winter warming speeds up the onset of the spring melt season. Aerosols represent perhaps the most complex, and least understood, group of Arctic short-term climate agents.
- **Tropospheric ozone**, caused by emissions from a variety of industrial and mobile sources, increases in the Arctic during fall, winter, and spring, a period when ozone's lifetime is comparatively long. Its potential contribution to the rapid 20th century Arctic warming is substantial: about 0.3°C annual average and even more, 0.4-0.5°C, during winter and spring, compared to a total estimated Arctic warming of over 1°C. Of future concern, ozone concentrations in the Arctic could substantially rise as summer shipping routes open across the Arctic and local ship emissions increase.
- **Methane** from a variety of industrial, agricultural and solid waste sources is, like CO<sub>2</sub>, a well-mixed greenhouse gas. However, its shorter atmospheric lifetime (8-10 years), and greater climate potency, means that reducing worldwide methane emissions, while not sufficient to stabilize Earth's climate, will reduce overall global warming much faster than would an equivalent volume of CO<sub>2</sub> reduction. In addition, methane contributes to tropospheric ozone formation (above), which means that global methane reductions will have added cooling impact by reducing Arctic warming from ozone.

The good news is that each of these pollutants is amenable to effective reductions using available technologies. At issue remains how to rapidly focus in on outstanding scientific questions, the answers to which can ground an all-out assault on these pollutants by the international community with the greatest scientific certainty possible.

## **Urgent Research Needs:**

Arctic researchers have identified the following priority areas to help close the gap on what needs to be known to develop and advocate for an Arctic climate initiative and protection plan focused on these short-term agents. These include:

- 1) Arctic-specific modeling to better quantify Arctic radiative forcing and temperature response to methane, tropospheric ozone, and black carbon.
- 2) Characterization of sources and source regions of black carbon reaching the Arctic atmosphere and depositing on arctic snow and ice surfaces.
- 3) Quantification of the winter warming capacity of Arctic haze and the extent to which winter warming is resulting in earlier onset of ice melt.
- 4) Examination of the interplay between tropospheric ozone precursors to develop an ozone precursor reduction plan that most effectively slows warming.
- 5) Better measurements of black carbon emissions from ship smokestacks.

Scientific understanding and a research agenda will be more fully fleshed out at an early November 2007 meeting in Oslo. At that meeting, scientists expect to:

- Describe how the forcing and temperature response by the short-lived pollutants currently are modeled and/or measured.
- Summarize the most up-to-date results concerning the impact of the short-lived pollutants on Arctic climate.
- Outline new approaches and research directions required for successful mitigation strategies.
- Develop strategies for optimizing IPY research on short-lived pollutants and Arctic climate.
- Consider mitigation strategies and recommendations for policy makers.
- Discuss what research disciplines need to be included to get a full understanding of how short-term climate forcings could be impacting Arctic temperature and melting.

Meeting results will be summarized and made available in time for the November Arctic Council meeting of SAOs in Narvik.

## **Annex 2. Unmanned Aircraft for Environmental Monitoring**

### **In support of**

### **The Arctic Monitoring and Assessment Program**

### ***Betsy Weatherhead, U. Colorado at Boulder***

Unmanned Aircraft are emerging as a capability to serve a number of important societal functions including facilitating communications and monitoring the environment. The Arctic is a key place for the use of unmanned vehicles for several reasons: the remote nature of the Arctic makes manned flights dangerous or, at times, impossible; the special geographic properties of the Arctic make satellite imagery difficult and highly uncertain; and the relatively sparse population of the Arctic makes risk lower than in some other parts of the world. Researchers are now developing new and original ways for adapting this tool for environmental needs.

#### **UAS Capabilities**

Unmanned aircraft come in a large variety of shapes and capabilities. Some are quite small, less than a meter in wingspan, and carry less than one pound of payload for distances of less than a few kilometers. Others are as large as some commercial jets, with wingspan of forty meters, ability to carry over one thousand kilos of payload for distances as far as 20,000 kilometers. These capabilities can be invaluable for scientists wanting to take remote measurements in harsh Arctic conditions. UAS can be sent into volcanic plumes for critical chemical composition measurements or can be used to monitor coastal and sea ice conditions. Many consider them the most valuable tool for monitoring marine mammals in remote locations. The development of this technology for environmental measurements is in its early stages, with new advances happening rapidly.

#### **Current and Future UAS Activity**

At a recent UAS meeting held in Paris, it was clear that most of the Arctic countries are already involved in these technologies for various purposes. Finnish researchers reported on the completion of a dedicated airfield for Unmanned Vehicles which became operational in 2007. Swedish colleagues spoke of launching one of the first unmanned vehicles from a civilian airstrip in 2001. A presentation from a Norwegian delegate showed a plan for using unmanned aircraft to support its communication and energy networks. Russian colleagues spoke of their UAS capabilities which are currently being used to monitor their pipelines and may be available for environmental measurements. International colleagues are currently working on flights over Greenland to allow for accurate surveying of the ice sheets. A major UAS meeting has taken place each year in Canada for over five years and addresses broad applications for UAS. University scientists in the US have used UAS near Barrow since 2001 to take environmental measurements of the sea and have further plans to take initial inventories of ice seals.

#### **UAS Coordination**

Because of the unique characteristics of the Arctic, this technology will be most useful in this area. The strong history of circum-arctic collaboration among the eight Arctic countries sets the stage for the eight Arctic countries to lead the way in developing appropriate policies for environmental use of UAS across the Arctic. AMAP and WMO are asked to help lead this effort and allow the international community to come together in agreement on critical issues regarding this valuable technology for environmental measurements. Specifically, AMAP is asked to establish points of contact within each of the Arctic countries for all notification and discussions concerning UAS for the environmental measurements in the Arctic. Additionally, AMAP is asked to convene a panel of experts from the Arctic countries to discuss principles for best practice in using UAS in the Arctic for environmental purposes. Due to the development of UAS efforts in most of the Arctic countries, these efforts should be taken as soon as possible, preferably within the next six months.