Kim Morris

Canada's Role in Arctic Sea Ice Research

The Arctic is undergoing dramatic environmental changes in the face of rising global temperatures. This note describes the recent changes in Arctic sea ice. It summarizes the research, monitoring, and modeling priorities suggested by Canada's Arctic research partners.

Overview

- Increasing global temperatures are having a significant effect on the Arctic environment.
- Changes in sea ice conditions have been dramatic and have environmental implications well beyond the Arctic.
- Changes in the Arctic represent both an environmental and political challenge.
- Canada needs to implement long-term environmental monitoring, satellite data acquisition and multi-scale computer modeling to address Arctic issues.
- Canada should continue to participate in the international organizations dedicated to coordinating Arctic research efforts.
- A broad range of stakeholders must be consulted to maximize the effectiveness of these research efforts.

Background

The Arctic is a region of increasing strategic and economic importance. It has a number of international stakeholders, including indigenous populations, natural resource industries, fishing communities, commercial shippers, the tourist industry, national security organizations, regulatory agencies, and the scientific research community.[1]

The Arctic has become a focus of scientific research because of its role as an amplifier and driver of global climate change. Policy imperatives involving Arctic climate change range from marine shipping to resource extraction, the vulnerability of civil and private infrastructure, and the preservation of endangered biotic and cultural assets. Just as the Arctic environment is rapidly changing, so are the scope and nature of national and international observing strategies and networks to monitor and understand the Arctic ecosystem. The data from these observation/monitoring activities can inform decisions made by policymakers.

Changes in the Arctic are driven by anthropogenic sources farther south, as a result of higher energy consumption, population increases, and expanding economies. Resulting Arctic changes are some of the most rapid on the planet because of multiple feedback linkages among loss of sea ice, greening of coastal regions, oceans, and atmosphere.[2]

Evidence of increasing global temperatures continues to accumulate. The last eleven years (2001–2011) were among the warmest years on record, and the first ten months of 2012 indicate that this trend will continue. In Canada, winter 2011–12 (December–February) was the third warmest, spring 2012 (March–May) the ninth warmest and summer 2012 (June–August) the warmest on record. Overall, Canada had its third warmest year-to-date.[3]

In the Arctic, sea ice reaches its maximum areal extent in March and minimum in September. The averaged March 2012 sea ice extent was 3.4% below the 1979–2000 March average. This year's lowest sea ice extent was recorded on 16 September and was 49% below the 1979–2000 average minimum (Figure 1). This is the lowest sea ice minimum in the 34-year satellite record.[3] In addition, the extent of thick, multi-year ice continued to decrease. This lack of thick ice could explain the dramatic decrease of sea ice extend this year.[4]

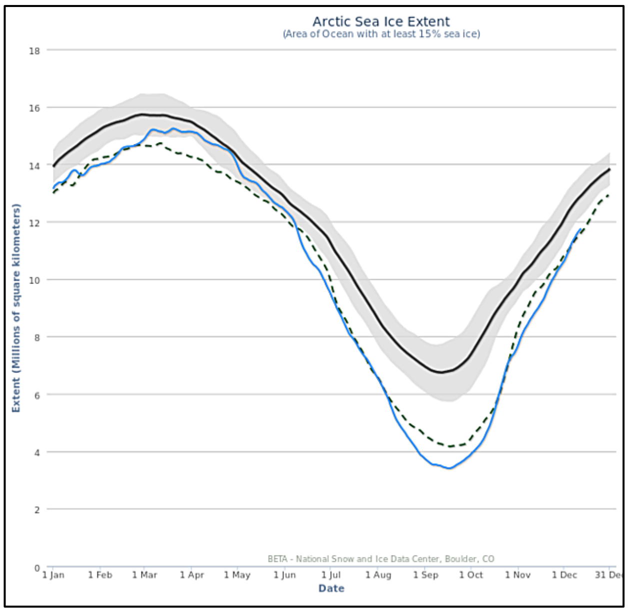

Figure 1. The Arctic sea ice extent. The solid blue line is 2012 sea ice extent; the dotted line is 2007, the black line is the 1979-2000 ice extent average and the gray zone is ± 2 standard deviations (Source: NSIDC, 2012)

Models predict that the Arctic Ocean will become nearly ice-free in summer within the next thirty to forty years.[7] This will result in greater marine access to the Arctic (e.g., for commercial shipping and offshore natural resource development) and increased coastal erosion, as well as a range of local, regional, and hemispheric changes in the climate and ecological systems.[1]

There remains a great deal of uncertainty about how fast the Arctic sea ice will change and what the ultimate impacts of these changes will be. Interactions ('feedbacks') between the sea ice and climate system are particularly uncertain. Concerted monitoring and research is needed to reduce this uncertainty.[5]

Arctic Research In Canada

The Government of Canada supported an active and productive sea ice program during the recent International Polar Year (IPY). Among its key findings were[6]:

- Open water persists longer than normal and winter sea ice is thinner and more mobile, In the Amundsen Gulf, at the western end of the Northwest Passage.
- Cyclones (low pressure atmospheric systems) play an important role in sea ice growth and decay by delaying the formation of new ice, reducing the growth of multi-year ice and breaking up multi-year ice in the late summer.
- The ice edges bordering flaw leads — regions of open water between pack ice and land-fast ice — are areas of high biological productivity.
- The Beaufort Sea Gyre (rotating ocean currents) formerly rotated clockwise throughout most of the year but now reverses directions regularly. This contributes to a reduction in sea ice thickness and extent.

Recently, Canada formulated a Northern Strategy, which establishes a research station at Cambridge Bay, Nunavut. The Canadian Polar Commission was reactivated and a Chairperson and commissioners appointed.[7]

The CCGS Amundsen remains a dedicated research icebreaker and Canada has seven other icebreakers, almost all of which support some research. Canada continues to develop the Polar Data Catalogue (PDC), initiated during the IPY. The PDC provides dataset description, indexing, data discovery, and full metadata archiving and sharing.[7]

International Cooperation and Coordination

The Canadian scientific community has a rich legacy of studies focused on local, place-based research. However, there is a need for Arctic-wide research that facilitates a holistic understanding of the Arctic as a system. This requires collaboration and cooperation with the other Arctic nations: Canada belongs to several such multi-national organizations (Box 1).

Box 1. Examples of Canada's Participation in International Arctic Research Organizations

The **Arctic Council**: a high level inter-governmental forum that promotes cooperation, coordination and interaction among member states on issues of sustainable development and environmental protection in the Arctic. Members: 8 Arctic countries.

Arctic Monitoring and Assessment Programme (AMAP): in part, reports on the state of the Arctic environment and gives advice to Ministers [of the Arctic Council] on priority actions needed to improve the Arctic condition.

Sustaining Arctic Observing Networks (SAON): aims to provide a diverse portfolio of policy-relevant observational information that enables better decision-making by a wide range of stakeholders (members include the Arctic Council (represented by AMAP)).

The International Study of Arctic Change (ISAC): provides a scientific and organizational framework for key science questions for pan-Arctic research. Goals are to observe, understand and respond to change. Members: Japan, China, Korea, Norway, Denmark, Canada, Russia, and the USA).

Arctic Ocean Sciences Board (AOSB): a non-governmental body that includes participants from research and governmental institutions in Canada and 18 other nations. Aims to facilitate Arctic Ocean research by supporting multinational and multidisciplinary natural science and engineering programs.

Exchange For Local Knowledge of the Arctic (ELOKA): provides data management and user support to facilitate the collection, preservation, exchange, and use of local observations and knowledge of the Arctic.

ArcticNet: brings together scientists and managers with Inuit organizations, northern communities, federal/provincial agencies and the private sector. Objective is to study the impacts of climate change and modernization in the coastal Canadian Arctic. Members: >145 researchers from Canadian universities, federal/provincial agencies and departments collaborating with international researchers.

These multi-national organizations seek to formulate and develop frameworks and goals for pan-Arctic research. This is accomplished by building consensus at meetings and workshops that include government officials, scientists, native communities and other stakeholders.

A comprehensive understanding of the Arctic environment can only be accomplished by combining continuous, long-term *in situ* environmental monitoring, supplemented with satellite data, and computer modeling. By coordinating their efforts, the Arctic nations can sponsor complimentary research and avoid duplication.

What follows is an abbreviated synthesis of the research, modeling and related recommendations made by a number of these organizations. [1, 8, 9, 10]

Research Priorities

1. Identify and address key gaps in our fundamental understanding of the Arctic environment and its connection to the global climate system.
2. Understand ecosystem processes, ecosystem services, and climate feed-backs in the Arctic.
3. Coordinate and improve integrated understanding of Arctic atmospheric processes.
4. Understand how the recent regime shift in the Arctic sea ice cover from predominantly multiyear to first-year ice affects the processes governing the atmosphere– sea ice–ocean system.
5. Establish specific key observational data requirements necessary for defining the initial ice–ocean state for seasonal sea ice predictions.
6. Treat the Arctic sea ice cover as an integral part of the complex Arctic system which, in turn, is an integral element of the global system
7. Execute a highly coordinated and integrated process-based study of seasonal sea ice focused on understanding the impact of the increasing predominance of younger, first-year ice on sea ice predictions.

Observations/Monitoring

1. Support long-term observation and monitoring programs of the Arctic environment.
2. Integrate and continue to deploy a national Arctic observing system and promote international cooperation to create a circumpolar observing system.
3. Monitor the biological and physical state of the Arctic marine environment.
4. Engage indigenous observers and communities in monitoring environmental parameters.
5. Identify, develop, and test instruments and observational platforms for sea ice monitoring.

Data Archiving and Access

1. Create a centralized information hub.
2. Provide access to all data at fast turnaround times.
3. Combine in-situ and remotely sensed observation of sea ice with local community and traditional knowledge.

Arctic Models (General and Sea Ice)

1. Inventory and evaluate existing Arctic modeling activities.
2. Integrate Arctic regional models.
3. Build Arctic-region models to couple with regional and global approaches.
4. Increase Arctic-model resolution to improve prediction and inform future research and observations.
5. Improve understanding of the principle drivers and uncertainties of Arctic climate changes through model validation and verification.

Stakeholders

1. Define the needs of the growing number of stakeholders.
2. Assess local-resident priorities with respect to climate.
3. Balance high-priority stakeholder needs against realistic predictive capabilities.
4. Engage policy-makers, scientists and other stakeholders in global cross-sectoral and interdisciplinary thinking to deal with increasing pressures on the Arctic.
5. Strengthen the relations between science and policy for more effective governance.

Policy

1. Recognize and address the links between the economy and the environment within the Arctic region, and between the Arctic and the rest of the world.
2. Foster coordinated support of Arctic research and related activities within the private and public sectors.
3. Provide guidance in allocation of resources to support the most promising avenues in addressing the most pressing needs.

These goals can only be achieved through a committed and deliberately integrative approach, founded on a sustained and coordinated conversation among all of the stakeholders.

Canada should contribute to these vital efforts by moving forward with the implementation of the Northern Strategy and fully funding the necessary Arctic research and infrastructure.

Endnotes

1 *Seasonal-to-Decadal Predictions of Arctic Sea Ice: Challenges and Strategies* - Committee on the Future of Arctic Sea Ice Research in Support of Seasonal-to-Decadal Prediction, Polar Research Board, Division on Earth and Life Studies (2012)

2 Overland, J., 2 October 2012, Polarization and Polar Climate, *International Polar Year 2012 Conference: From Knowledge to Action; Montreal, Quebec, Canada, 22–27 April 2012, Eos*, Vol. 93, No. 40, page 390.

3 WMO, 28 November 2012, *Provisional Statement on the State of Global Climate in 2012*.

4 Perovich, D., et al. December 2012, *Sea Ice*, Arctic Report Card 2012.

5 *Arctic Climate Issues 2011: Changes in Arctic Snow, Water, Ice and Permafrost* (Arctic Monitoring and Assessment Programme (AMAP)).

6 *International Polar Year Canadian Science Report – Highlights* (Canadian Polar Commission – 2012)

7 *International Collaboration and Cooperation in Arctic Environmental Change Programs - Planning for the Future* (2012).

8 *Report on the Goals and Objectives for Arctic Research 2011-2012 For the US Arctic Research Program Plan* (US Arctic Research Commission).

9 *Interagency Arctic Research Policy Committee Arctic Research Plan: FY2013 – 2017* (Sept 2012).

10 Johnsen, K. I., Alfthan, B., Hislop, L., Skaalvik, J. F. (Eds). 2010. *Protecting Arctic Biodiversity*. United Nations Environment Programme, GRID-Arendal, www.grida.no.