Taking action on climate change

Together, we can do it.

CLIMATE SCIENCE IN CANADA

the arctic

The Government of Canada created the Climate Change Action Fund in 1998. The Science constituent within the Science, Impacts and Adaptation component of the Fund supports research to increase our understanding of the climate system, how it operates, and how it might change.

Canadian Ice Service

Climate Science

Mounting scientific evidence confirms that the Earth's climate is changing, fuelled by increasing atmospheric greenhouse gases produced by human activities.

How much change are we talking about? Climate monitoring indicates that the global average temperature has increased more in the last century than over the past 1,000 years at least. According to the *Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*, released in 2001, the global average surface temperature is expected to further increase between 1.4 and 5.8°C in this century. This rate of change is unprecedented in at least the past 10,000 years.

Global averages give the big picture, but changes to regional climate help us understand how warming will affect Canadian society and the environment. And while regional changes are still difficult to predict, climate models already reveal that large parts of Canada will experience greater warming than the global average.

While there may be benefits in certain regions, warmer temperatures could also mean changes in water supply, leading to more drought in some areas and increased flooding in others. Extreme weather events, such as heat waves and storms, could also become more frequent and more severe, causing damage to property and endangering people's lives.

To make informed decisions on tackling climate change — by reducing greenhouse gas emissions and adapting to anticipated impacts, for instance — we need a better understanding of the climate system and how it responds to increasing levels of greenhouse gases. Through climate change research, scientists track the climate, gain insight into how and why it is changing, and estimate future climate.

Climate Change and the Arctic

The people living in Canada's North, including Inuit elders and hunters, are telling us that they are already experiencing the effects of climate change. Changes to species and wildlife abundance, and the impact of changing ice conditions are only some of the impacts being experienced. In the past 40 years, annual temperatures in the western Arctic have climbed by 1.5°C, while those over the central Arctic have warmed by 0.5°C.

As a northern nation, Canada is expected to experience a greater degree of warming than elsewhere. As the world's climate changes, temperature changes are anticipated to be greater in the North and greater in winter than in summer. According to recent climate models run by Environment Canada, annual temperature increases of greater than 5°C in the Arctic are possible by the year 2100.

Climate Change Science in the Arctic

The Arctic has some special features that make it an important focus for climate research. Physically, the Arctic islands are entirely snow-covered for more than half the year, and the region contains mountain glaciers, ice caps and extensive areas of permafrost. Arctic waters are also covered with sea ice for most of the year. Changes in the amount of sunshine are extreme since the Arctic experiences periods of 24-hour sunlight and 24-hour darkness at different times of year. Also, while large parts of the Arctic are essentially desert-like, large expanses of open water do occur during the short summer, making the Arctic a significant source for moisture and clouds. Northward-flowing rivers such as the Mackenzie empty their waters into the Arctic Ocean, influencing the ocean's physical characteristics. There are also important large-scale climate patterns, such as the Arctic Oscillation, where atmospheric pressure in the Arctic switches between high and low, causing shifts in climate and weather patterns in the Northern Hemisphere. These factors produce a complex interplay among climate processes in the Arctic.

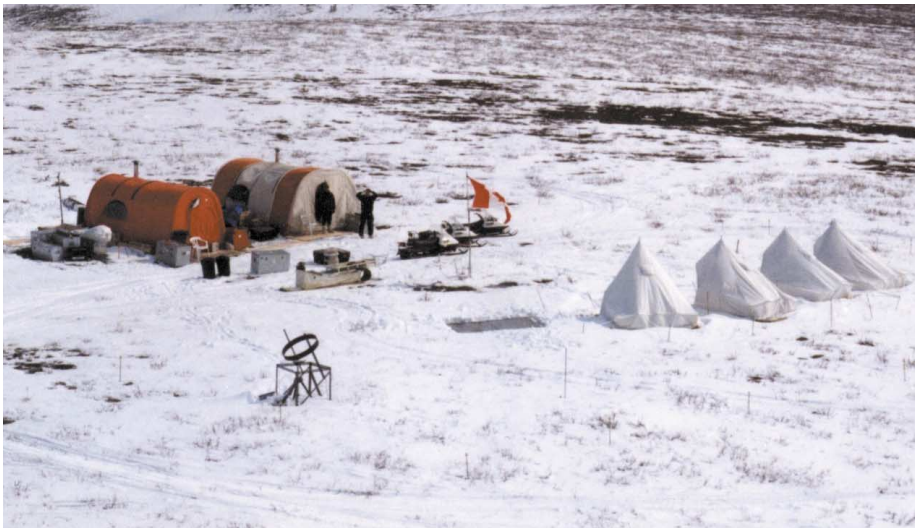
The North also offers many interesting clues to the past climate found in glacier ice cores, permafrost temperatures, ground ice, pollen and lake sediments, and tree rings. The data from these sources can be assembled into an integrated description of how high-latitude past climate has evolved.

These features make it critical for scientists to study the Arctic climate system. In Canada, efforts to develop climate models are incorporating important factors, such as the role of sea ice. Research teams are also studying important processes, such as the role of snow, clouds and the oceans, that characterize the Arctic climate system, and are working with Arctic climate observations to correctly interpret and understand trends in global climate. Overall, Canadian scientists have been leaders in international efforts to understand the Arctic climate system.

Climate Change Action Fund: The Arctic

The Climate Change Action Fund (CCAF) identified the Arctic climate system as a priority area of study. Several research projects were funded following a national workshop held in 1999 to identify specific Arctic climate science issues. The work supported fell into two broad areas:

- advancing our knowledge of the climate system (ocean, atmosphere, land and cryosphere



Phil Marsh, Environment Canada

At this field camp north of Inuvik, NWT, researchers study the water cycle to better understand climate trends in the North.

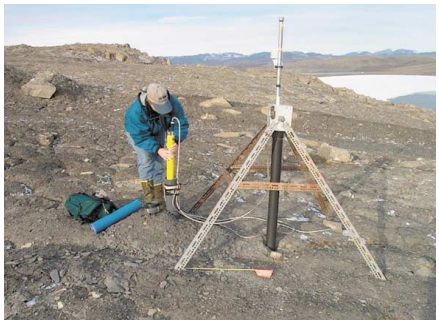
– primarily ice in all its forms, snow and permafrost) for Arctic Canada;

- rescuing and maintaining long-term data sets of importance to determining variations in the climate of Arctic Canada.

Four projects contributed to our knowledge and understanding of the changing climate system in Arctic and sub-Arctic Canada.

- A comprehensive look at the response of the Arctic cryosphere to the unusually warm summer of 1998 revealed that, while other summers over the past 30–40 years were comparable in terms of melt intensity, 1998 was characterized by an abnormally long melting season.
- Detailed information on the climate and hydrology of two research drainage basins near Inuvik and Tuktoyaktuk was compiled. It showed that there was significant year-to-year variability in temperature and snow, and that break-up of ice in spring was occurring earlier.
- Another study integrated the long-term records of sea ice and ocean circulation over Arctic continental shelves. The researchers found dramatic interannual variability in all elements examined.
- Using climate model information, researchers found that important large-scale atmospheric circulation patterns, such as the Arctic Oscillation, may change with global climate warming.

Several projects compiled data from various sources and then studied the information to improve our understanding of the Arctic climate system.



Daniel Riseborough, Natural Resources Canada

Changes in the permafrost as measured at this monitoring site near Alert, Nunavut, can affect buildings, roads and airstrips.

- Researchers reactivated permafrost temperature monitoring sites at key locations in the Arctic. Initial analysis of data retrieved from the field indicates considerable ground temperature variability at various depths between sites and from year to year during the 1990s.
- Scientists integrated data from a variety of sources known as "proxy" data sources, mainly ice cores and tree rings, to create a record of temperatures of the circumpolar North for the past few centuries.
- Researchers synthesized available proxy climate information from pollen data and other indicators going back 10,000 years. They found that the Arctic was relatively warm several thousand years ago, but had generally been cooling until recently. The recent human-induced warming is not simply a reversal of the long-term cooling trend, as it seems to be more extensive and have a different spatial pattern.
- A compilation and synthesis of 40 years of climate and biophysical information from the St. Elias Mountains and surrounding ranges has been undertaken. The longer-term objective is to establish a common digital database for these time series records in the southwest Yukon. Initial analysis indicated significant climate-related changes in populations of Dall sheep, other herbivores and vegetation.
- Scientists can estimate the amount of human-created carbon trapped annually in ocean areas such as the Labrador Sea by looking for "tracers" of human-made elements such as chlorofluorocarbons (CFCs). Researchers compiled and did an initial synthesis of data collected on research missions to the Labrador Sea and the Arctic Ocean during the late 1990s.

Several studies focused on the maintenance and rescue of relevant sets of climate data. These data sets will now be available for future research studies.

- Researchers compiled an inventory of High Arctic data, including the locations of more than 600 field camps, oil industry sites, historical expeditions and automated station sites within the High Arctic islands. The data sets provide snapshots of the climate at times and places not represented by the permanent observation network.
- Several databases of importance to climate change, such as permafrost and peatlands, are now accessible through the on-line National Arctic Geoscience Database (NAGD), providing information on the evolution of climate systems in the Canadian Arctic over the past several thousand years.
- Since the late 1980s, various researchers have been gathering

climate-related data (such as tree ring information) at a network of about 70 stations across northern Quebec. This study has put in place a method to transfer raw data collected at various sites into an interactive database.

- Working from the complete hydrometric database for Canada, researchers have assembled an archive of ice break-up data for northern rivers. A total of 143 stations are in the basic archive, and 35 stations have been selected to form the basis of a first regional assessment of historical trends and the severity of ice-induced extreme water-level events.
- Researchers compiled and archived the ice thickness, ocean current and water property data collected at the Arctic Ocean Climate Station in the Beaufort Sea from 1990 to 1995.
- A research team assembled all the information on ocean current, temperature, depth and related aspects from Arctic oceanographic surveys conducted in the late 1970s and early 1980s. The data are now available digitally and can be obtained from the Fisheries and Oceans data archives at the Bedford Institute of Oceanography.

What's Next

Action Plan 2000 on Climate Change, the Government of Canada's strategy to help meet our commitment under the Kyoto Protocol, is funding climate monitoring activities. Ten million dollars of Action Plan 2000 resources are targeted towards Canada's atmospheric, oceanographic and cryospheric networks; several of these activities have an Arctic focus. Federal departments are working with Canadian universities and provincial and territorial agencies on such activities as:

- expanding Canada's contribution to atmospheric monitoring as part of the international Global Climate Observing System Surface Network, particularly in the North;
- deploying a series of ocean floats to measure temperature and salinity in Canadian waters, and a series of tide gauges in Canadian Arctic waters; and
- enhancing and/or establishing Canadian monitoring systems for snow, permafrost, glaciers, and sea and freshwater ice.

In addition, the second phase of the CCAF will support work on continued improvements to climate models, including better representation of the Arctic climate system. The CCAF will also be funding projects addressing aspects of the Arctic climate system that are not well understood, including aspects relating to the Arctic sea ice and Arctic Ocean dynamics, clouds and aerosols, and snow-covered ground. As well, to help ensure Canada has the scientific tools and capacity to tackle climate change over the longer term, a Climate Science Agenda for Canada is being developed. One crucial scientific question that has serious implications for the Arctic, its ecosystems, and the people who live there, is the rate at which the sea ice might disappear. This will be one of the science research priorities in the *Climate Change Plan for Canada*.

WEB SITES:

Canadian Cryospheric Information Network:
www.ccin.ca
www.crysys.ca

National Arctic Geoscience Database:
http://sts.gsc.nrcan.gc.ca/clf/geoserv.asp

Department of Fisheries and Oceans, Bedford Institute of Oceanography, Sea Ice Web Site:
www.mar.dfo-mpo.gc.ca/science/ocean/seaice/public.html

This fact sheet is one in a series describing key topics in climate science and Canada's activities.