Environment Canada Environnement Canada

THE METEOROLOGICAL SERVICE OF CANADA

Annual Report 2000-2001

Canada

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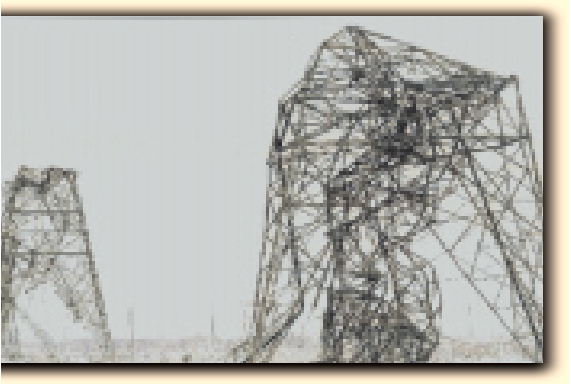
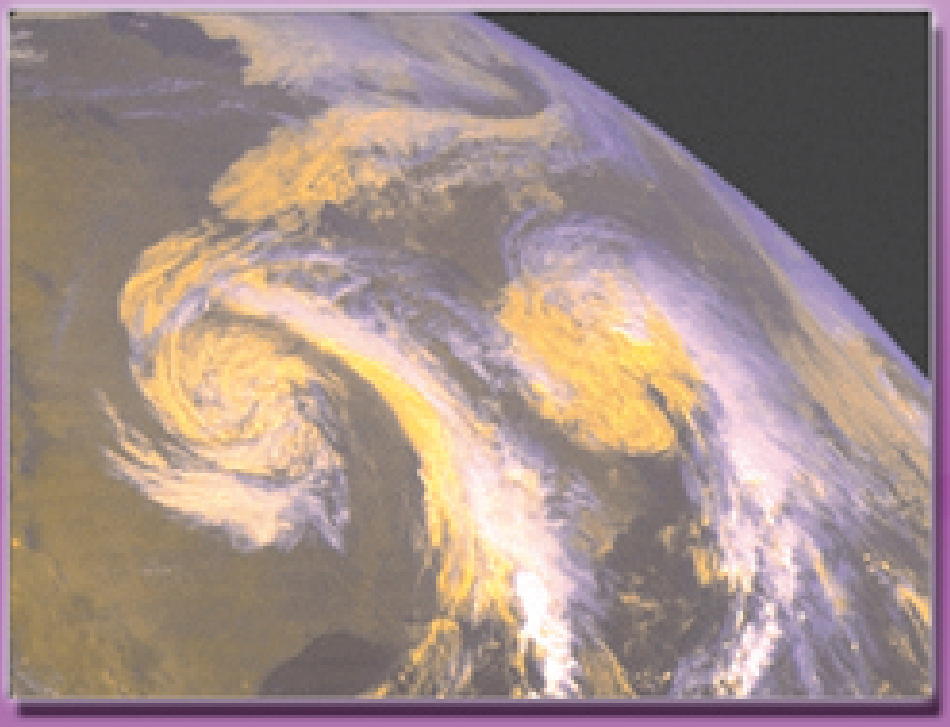
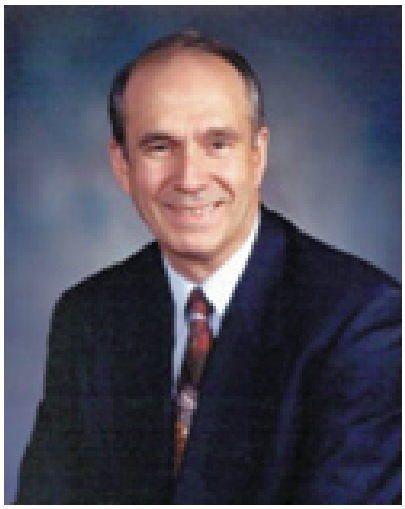




Foreword from the

Assistant Deputy Minister



The Meteorological Service of Canada is one of Canada's oldest federal institutions. It has been delivering weather information to Canadians since 1871. As a Departmental Service Organization within Environment Canada, the MSC is responsible for all activities related to weather forecasts and warnings, the ice service and the science of meteorology, climate and air quality.

During 2000-01, the MSC produced thousands of public weather forecasts and warnings, as well as providing ice, climate and water information to our stakeholders. In addition to this we received millions of phone calls and millions more visited our web sites.

However, you will see in reading this year's Annual Report that the MSC is much more than weather forecasting. Together with our partners in the provinces and in universities, we delivered services such as water quantity monitoring, and made progress in climate change modeling, measured and studied air pollutants and greenhouse gases, and contributed to the advancement of atmospheric sciences at the international level.

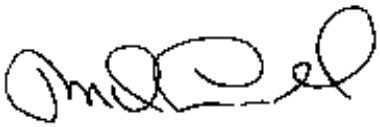
We continued to update our technology to better serve and protect Canadians, by installing new Doppler radars and upgrading weather and water monitoring equipment.

Clean air is a priority for the Government of Canada and for Environment Canada, and in 2000-01, MSC contributed to this priority by expanding our air quality prediction programs.

The past year also saw the continuing review of the MSC's programs, to improve our service delivery to Canadians in an efficient and cost-effective manner.

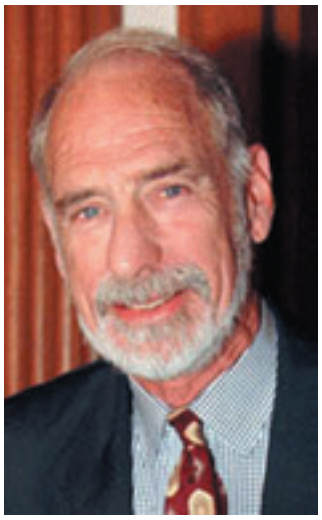
I am optimistic about MSC's future because I know the people that we have, the research that we do and the services that we provide make us an example of excellence in government. This year marks the 130th anniversary of our Service. I believe that we can set the course for another 130 years of providing core, leading-edge government service to Canadians and the private sector and helping Canada remain one of the best countries in the world in which to live.

As the Assistant Deputy Minister of the Meteorological Service of Canada, I am pleased to share this Annual Report for 2000-2001.



Marc Denis Evrard

Message from the Minister



This first Annual Report from Environment Canada's Meteorological Service of Canada (MSC) summarizes the activities that the MSC carried out to fulfill their mandate to protect the health and safety of Canadians.

The MSC is a unique and essential service of the federal government. It contributes to the health, safety and economic prosperity of Canadians by providing accurate and accessible information on daily weather, water and ice conditions from coast-to-coast. MSC helps to safeguard Canadians from environmental emergencies (natural or man-made), and provides support to other federal departments with security mandates, such as the Department of National Defence and the Department of Fisheries and Ocean's Canadian Coast Guard.

The MSC has been serving Canadians since 1871, when the national weather service was created to provide warnings to mariners on the Great Lakes and the St. Lawrence River. Today, some 1750 staff form part of a nation-wide Service running everything from air-quality research stations, weather offices and water stations to ocean buoys and satellites.

The work done by MSC benefits every Canadian and almost every branch of the public and private sectors in very direct ways. Weather services are among the most frequently used federal government services— polls show that virtually all Canadians surveyed listen to at least one weather forecast daily.

The MSC also plays a key role in providing the federal government with the scientific information and data needed to move forward in developing the right policies to address Clean Air, Clean Water and Climate Change.

There is a long history of MSC providing quality service to Canadians and I am proud to say that this tradition will continue.

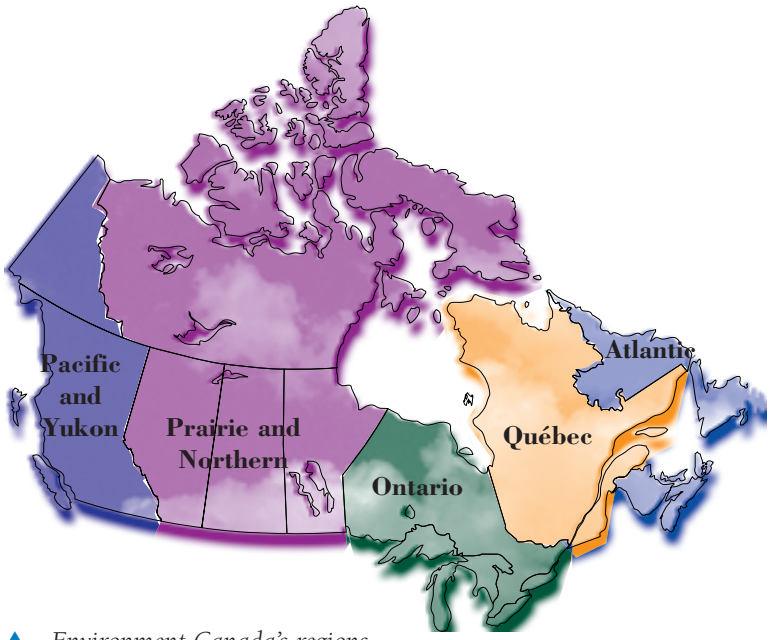
The Honourable David Anderson, P.C., M.P.
Ottawa, Ontario

Who We Are

Canada's first national weather service was established in 1871, while water survey activities were officially recognized in 1908. As aviation needs for weather expanded after World War II, the weather service was managed as part of the Department of Transport. In 1971, meteorological and hydrological functions moved to the newly created Department of the Environment. In late 1999, the Meteorological Service of Canada was formally designated as a Departmental Service Organization within Environment Canada, with responsibility for weather prediction, weather warnings, the national water survey, the ice service and the science of climate and air quality.

MSC is an important part of the way Environment Canada delivers services and science that promote the health, safety and economic well-being of Canadians.

Our programs are delivered through Environment Canada's five regions, as well as by staff at MSC offices in Downsview, Ontario, Dorval, Quebec, and the National Capital Region.



▲ *Environment Canada's regions*

ORGANIZATION CHART FOR THE MSC

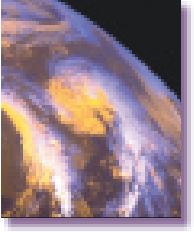
Marc Denis Everell
Assistant Deputy Minister

MSC Regional Directors
P&Y Region
P&N Region
Ontario Region
Quebec Region
Atlantic Region

CORPORATE ADVISORS
P&A
HR
Comm

DIRECTOR GENERAL Atmospheric Monitoring and Water Survey	DIRECTOR GENERAL Atmospheric Environment Prediction	DIRECTOR GENERAL Atmospheric and Climate Science	DIRECTOR GENERAL Services, Clients and Partners	DIRECTOR GENERAL Policy and Corporate Affairs
National Weather and Climate Network	National Prediction Programs	Air Quality Research	Natural Resouce Sector Services	Associate Director General
National Radar Project	CMC - Operations	Climate Research	Aviation and Defence Services	Business Planning & Development
National Weather and Climate Operations	CMC - Informatics	Meteorological Research	Ice and Marine Services	Policy and International Affairs
Data Standards and Quality Management	CMC - Development	Adaptation and Impacts Research	Meteorological Services and Business Policy	Strategic Capital Planning
Water Survey		Science Assessment		Special Projects
National Archives and Data Management				

▼ *MSC Headquarters offices, Thomson Laboratory and MSC Ontario region offices in Downsview, Ontario*



▲ *Snow technician taking a sample*

MSC ADVISORY BOARD

The MSC also receives guidance from a newly created Advisory Board. This Board, made up of senior executives from a variety of stakeholder and client groups, first met in April 2001. The Board's purpose is to provide client-focused advice to the Assistant Deputy Minister on MSC's programs and priorities; to review technical reports concerning MSC's activities and their relationship to other parts of Environment Canada and stakeholders; and to promote co-operative programs involving the MSC with the private sector, other federal departments, universities and provincial government agencies.

The following members form the Board of Directors:

Dr. John ApSimon
Special Science Advisor to the Deputy Minister
Environment Canada

Mr. Richard Cavanagh
Vice-President, Radio
Canadian Association of Broadcasters

Superintendent P.A. (Phil) Duffield
Bureau Commander, Field & Traffic Support Bureau
Ontario Provincial Police

Brigadier General Marc Dumais
Chief of Staff / Deputy Chief of Defence Staff
Department of National Defence

Mr. Ashkon Hashemi
Internal Co-ordinator, Canadian Federation of Students

Ms. Azzah Jeena
Program Officer, Partners for Climate Protection Program
Federation of Canadian Municipalities

Mr. Allan Jeffrey
Director, Canadian Interagency Forest Fire Centre

Mr. Paul Kovacs
Senior Vice President, Policy Development & Chief Economist
Insurance Bureau of Canada

Mr. Andris U. Vasarins
Vice President, Operations
NAV CANADA

Mr. David Egar
Director General, Air Pollution Prevention
Environmental Protection Service
Environment Canada

Mr. Marc Denis Everell
Assistant Deputy Minister
MSC, Environment Canada

Mr. Robert Friesen
President
Canadian Federation of Agriculture

Mr. David Grimes
Director General, Services, Clients & Partners Directorate
MSC, Environment Canada

Mr. Sonny MacDonald
Fort Smith, Nunavut Territory

Mr. John Mills
Regional Director General, Ontario Region
Environment Canada

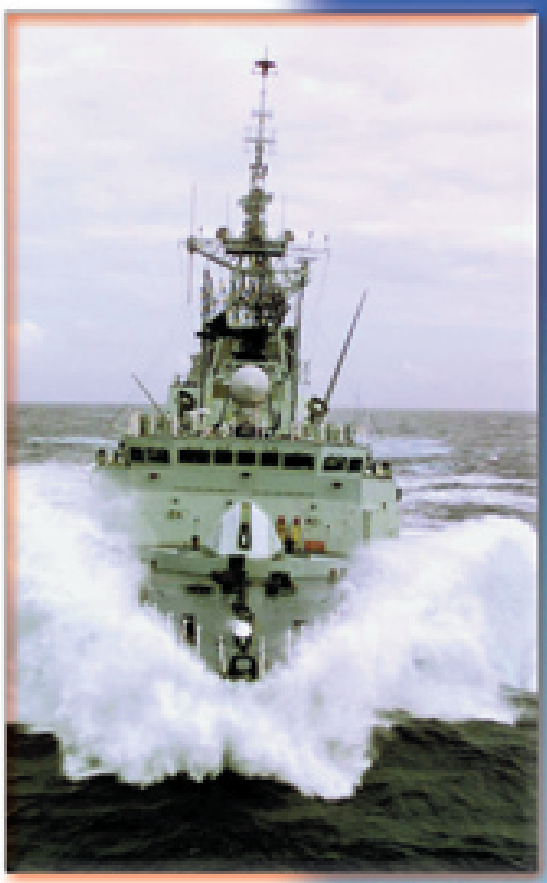
Mr. Pierre Morrissette
President & CEO
Pelmorex

Dr. Samuel Scully
Vice President, Academic Research
Dalhousie University

What We Do

The Meteorological Service of Canada:

- provides weather forecasts and warnings of extreme weather events and hazardous air quality;
- monitors atmospheric conditions and the quantity of water in Canadian lakes and rivers;
- forecasts ice and wave conditions on navigable oceans and inland waters;
- monitors and predicts the state of the climate and;
- leads the development of atmospheric science and related environmental prediction in Canada.



Highlights of 2000-2001

1. SAFETY FROM ENVIRONMENTAL HAZARDS

One of MSC's key goals is to reduce the risk to Canadians from weather-related environmental hazards. In addition to providing over 14,000 severe weather warnings annually, the following are examples of specific activities undertaken during 2000-01 to safeguard the health and safety of Canadians.

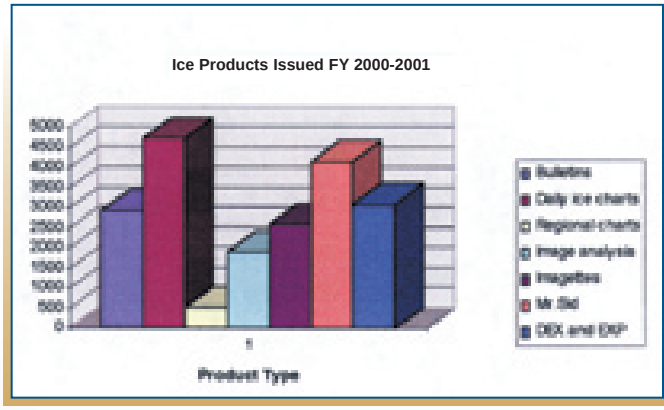
Storm Surge Warnings

Our Maritimes Weather Centre implemented an ocean model system to predict storm surges—the first such operational system in Canada. The model allowed meteorologists to successfully predict several storm surge events 48 hours before they occurred, including one on January 21, 2000, that caused considerable coastal flooding and damage in Prince Edward Island (PEI) and eastern New Brunswick. MSC forecasters used the model to identify areas at risk of flooding, and alerted the Emergency Measures Office in PEI. High-Water Watches warned the public of flooding dangers and allowed them to take protective action.

The development of this storm surge model was a result of collaboration between MSC researchers, other government departments such as Department of Fisheries and Oceans, Dalhousie University and industry. (more details can be found in our Partners section)

Ice Services

Ship captains, fishers and other marine operators must contend with sea ice and icebergs for much of the year in eastern and northern Canada. To assist marine transportation and ensure the safety of vessels and their operators, MCS's Canadian Ice Service produced almost 20,000 ice information products in 2000-01, including some 3,000 bulletins advising of dangerous ice conditions such as extreme ice pressure or the rapid closing of open-water leads.



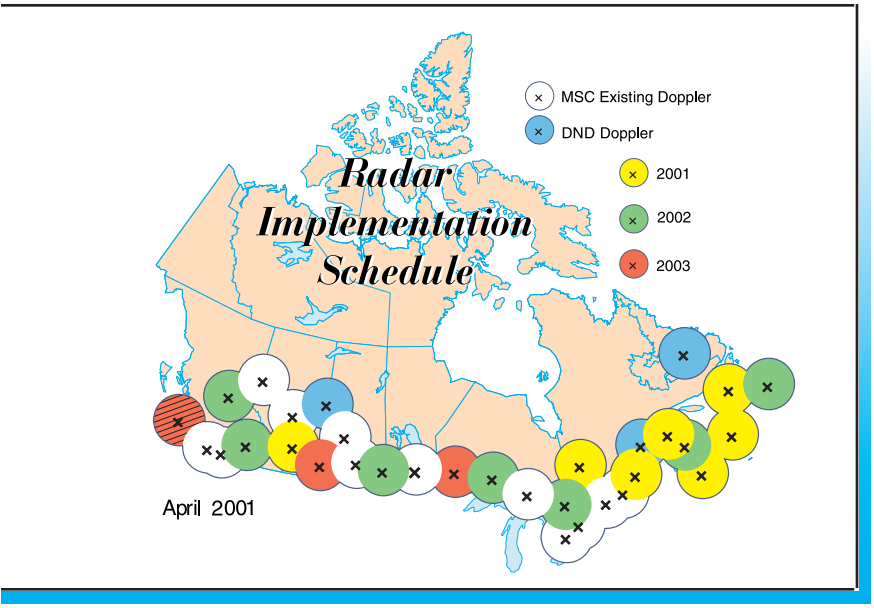
▼ *Storm surge damage in P.E.I.*

Traditionally, Inuit people use landfast ice as a transportation corridor during the fall, winter and spring. Occasionally, an unexpected breakup has left people stranded on ice floes drifting away from shore. Although deaths are very rare, the search and rescue effort required to retrieve stranded individuals is costly. 2000-01 was the second of a three-year project, financed in partnership with the National Search and Rescue Secretariat, to investigate the feasibility, effectiveness and cost of issuing landfast ice breakup warnings to northern communities, which were provided this year to the communities of Arctic Bay and Pond Inlet.

▲ *Weather radar installation in Franktown, Ontario*

Weather Radar

The MSC's network of conventional and Doppler radar covers 95 per cent of Canada's population. Doppler radar is a key tool in improving the detection and prediction of environmental hazards, such as severe weather and floods. The National Radar Project is a multi-year plan to convert all weather radars to Doppler. When it is completed, 31 Doppler radars will be in operation. To enhance staff skills in the science of severe weather detection, Doppler radar training was provided to forecasters in the regions via workshops and through self-study modules on the Internet.



During the year 2000-01, five radars were installed or upgraded: Franktown (Ottawa), King, and Montreal River (Sault Ste. Marie), in Ontario; Spirit River, in Alberta; and Victoria, in British Columbia. The Marble Mountain radar near Corner Brook, Newfoundland, was installed, but work on the antenna and radome could not be completed due to high winds. The site is one of seven slated for completion in 2001-02.

Highlights of 2000-2001 (con't)

▲ *RWIS sensor*

Road Weather

Each year, approximately 300 Canadians are killed and 11,000 injured in road accidents in which snow and ice are a major cause—more than the annual total for all other transportation-related accidents.

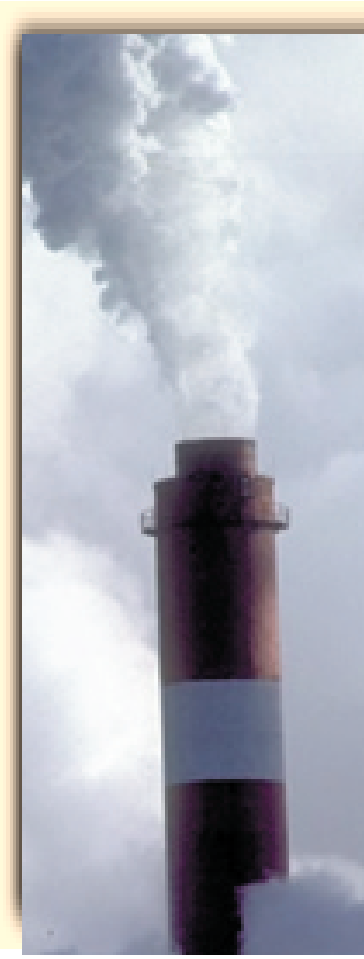
Many provinces and municipalities are installing hi-tech Road Weather Information Systems (RWIS)-automated weather stations that are located adjacent to roadways and have sensors in the surface and substrate of the pavement. These systems record atmospheric conditions such as air temperature, relative humidity and wind speed, as well as the temperature and wetness of the roads. Using this data, meteorologists can produce accurate forecasts of the road surface temperature and condition. Road maintainers use the data and forecasts to treat roads proactively, before snow and ice bond to the road and reduce road friction. This provides significant safety improvements with lower salt use.

During 2000-01, all MSC Regions partnered with provincial or municipal road authorities to provide road weather services on a cost-recovery basis. Good progress has been made on negotiations with Transport Canada, the provincial transport ministries, and the private sector on a national integrated road weather system for Canada.

Air Quality Forecasts

Poor air quality causes an estimated 5,000 premature deaths per year in Canada. In addition to conducting research on air quality issues, the MSC works with provincial and municipal partners to deliver better air quality information to the public.

Since 1997, when we launched a pilot smog prediction program in Saint John, New Brunswick, in partnership with the New Brunswick Department of Environment, daily air quality forecasts have expanded to include the rest of New Brunswick, Nova Scotia and Prince Edward Island. During 2000-01, air quality forecast models continued to be enhanced, and a national smog web site was introduced with links to provincial sites.



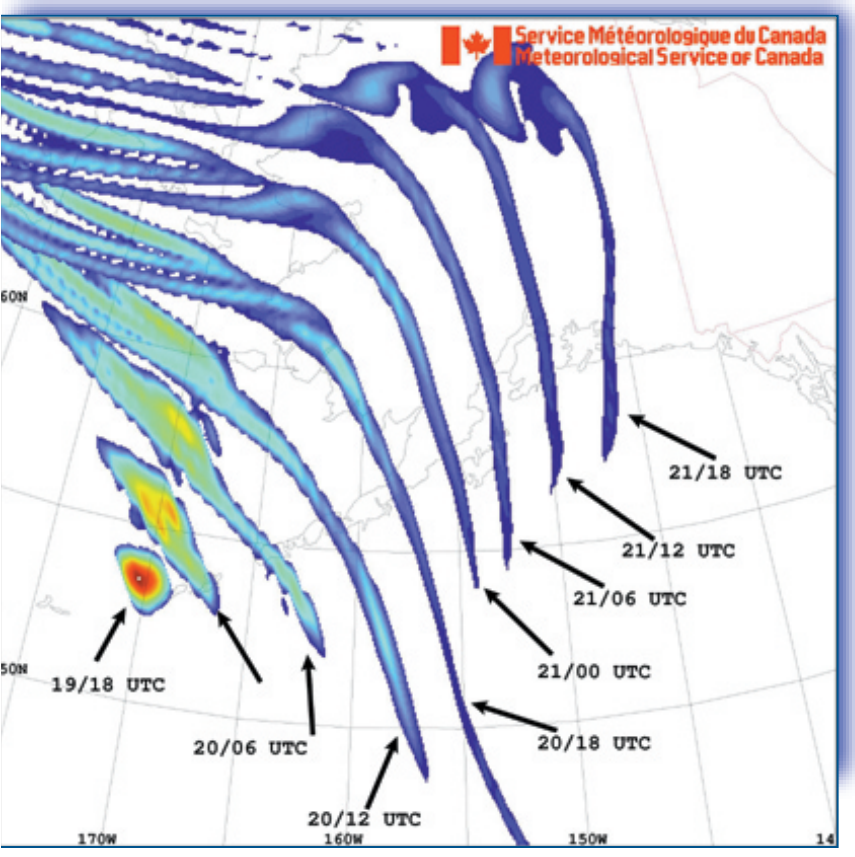
A daily winter air-dispersion forecast was initiated in the Greater Montréal area and in British Columbia, an experimental air quality forecast was produced for the Lower Fraser Valley and distributed to the Greater Vancouver Regional District. In Ontario, meteorological support continued to be provided to the provincial Ministry of the Environment for air quality forecasting programs.

Emergency Response

The MSC plays an important role internationally in coordinating emergency responses to events such as nuclear accidents and volcanic eruptions. Our Canadian Meteorological Centre (CMC) is one of eight centres in the world that predict the path of radioactive material and volcanic ash in Canadian and international territories. This work also supports Canada's efforts to implement the Comprehensive Nuclear Test Ban Treaty (CTBT).

Volcanic

CMC monitored approximately 15 ash clouds during 2000-01, including ones produced by volcanoes in Kamchatka, Montserrat, Mexico, and Central and South America. Although most were far from our area of responsibility (i.e. Canada, Greenland, the North Atlantic and the Arctic Ocean north and north-east of Greenland), significant eruptions of Mount Cleveland in the Aleutian Islands in February and March 2001 produced two large ash clouds that came very close to Canadian airspace. Close monitoring of the clouds was carried out with the assistance of the Anchorage Volcanic Ash Advisory Centre and the Kelowna Weather Services Office.



▲ *Composite picture of volcanic ash cloud forecasts following Mt. Cleveland's eruption on Feb. 19, 2001. Dates are from Feb. 19 to 21, 2001 and times are indicated in Coordinated Universal Time (UTC).*

Nuclear

CMC was informed of five minor incidents at nuclear power plants in Canada and the US during 2000-01, but none required a response. We also participated in international nuclear emergency response tests in May and June 2000—the first, for the CTBT, and the second, a joint exercise with the World Meteorological Organization and the International Atomic Energy Agency that simulated an accident at a nuclear plant in Brazil. We also conducted monthly tests of the 24-hour operational system and procedures with our US and Australian counterparts.

Walkerton Inquiry

The E. coli outbreak and deaths in Walkerton, Ontario, in May 2000 raised a potential weather and water-quantity link to health, since heavy rainfall in the area was a possible contributing factor to the water supply contamination. An MSC-Ontario region meteorologist led a team that assessed the historical significance of the high rainfall, and developed estimates of the frequency of similar or greater accumulations. The amounts were found to be high for the area, but not unprecedented. On January 15, 2001, MSC-Ontario's presentation to the Walkerton Commission on the meteorological events that occurred prior to the outbreak elicited thanks from the presiding Mr. Justice O'Connor.

Education and Awareness

To help Canadians better understand and use the information we provide, we are involved in various education and awareness-building activities.

Highlights of 2000-2001 (con't)

Sky Watchers Program

An example of a program to reach school age children is Sky Watchers. Sky Watchers is a bilingual, interactive educational program for Grades 4 to 7, designed specifically to support the science curriculum. Students learn about meteorology through classroom instruction and hands-on activities, including taking daily weather observations.

Sky Watchers was introduced in our Pacific and Yukon region in 1994, and is now in full operation in British Columbia, the Yukon, Ontario and Atlantic Canada. In Quebec Region, a pilot program took place during the 2000-01 school year in partnership with the Montréal Biosphere. Global Television Network is also sharing in the costs of the program in Quebec, and issued a network-wide Sky Watch weather observation each evening.

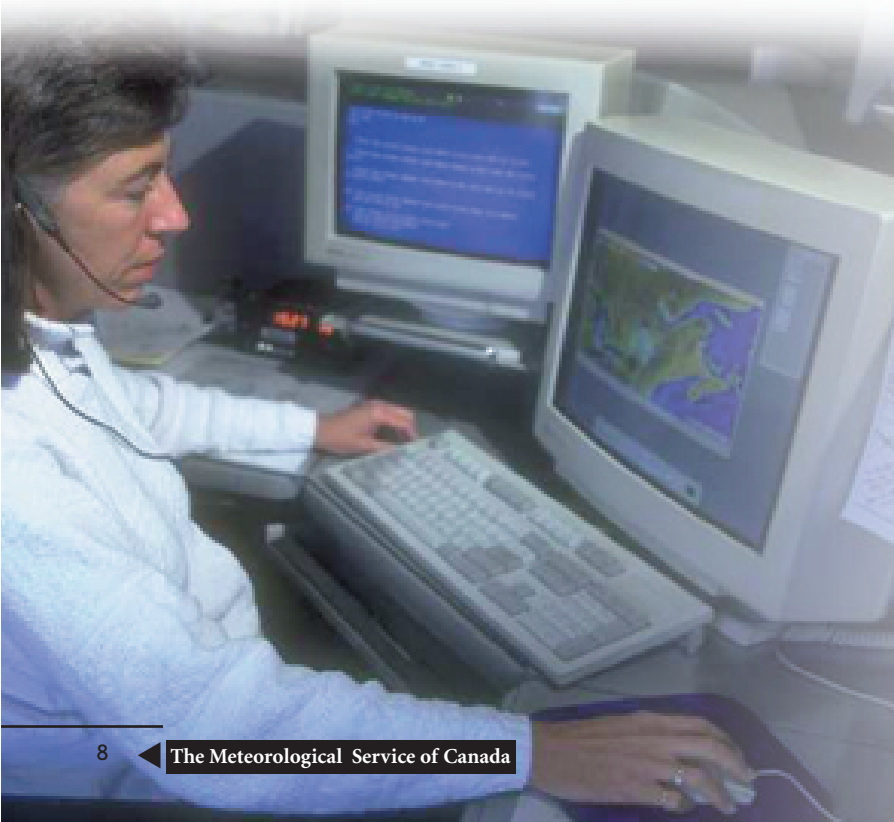
2. PARTNERSHIPS

We work with partners in almost everything we do. Our research and development is conducted in collaboration with universities, research institutes and private sector partners both in Canada and internationally. Partners such as the media and the provinces are essential in the delivery of services to protect the public from environmental hazards such as storms and floods, and in promoting educational and outreach activities. We also work within Environment Canada, other government departments and international organizations in developing assessments and policies on a national and global basis to protect and conserve our natural environment.

NAV CANADA

More than 150 MSC personnel provide a broad range of weather services in support of civilian aviation in Canada under an agreement with NAV CANADA—the not-for-profit corporation that operates the national air navigation system. Over the past year, we commissioned several new automated weather observation stations in the Arctic, responded to numerous requests for studies and product development, and completed a transition to a universally praised new graphical aviation forecast product called the GFA.

The GFA is revolutionary because it replaces a text-based product that had remained virtually unchanged for the past 50 years. Working closely with our partners on the design, we now produce a forecast that shows the same information in graphic format, making it much easier for aviators to interpret and thus enhancing the safety of the flying public.



NAV CANADA Flight Services Specialist using Weather Graphics System provided by MSC

Department of National Defence (DND)

In 2000-01, Environment Canada and DND renewed their long-standing relationship under a five-year Memorandum of Understanding. Over 80 MSC personnel provide customized weather and oceanographic services, including information technology (IT) and training services, to the Canadian Forces. To serve military operations overseas, IT specialists at the Canadian Meteorological Centre and Aviation and Defence Services Branch have developed software and techniques for predicting weather at any location in the world where Canadian Forces are stationed. A new Web site provides our products to every desktop within DND and to Canadian Forces members deployed globally. We provide specialized meteorological information and briefings to DND in support of their Search and Rescue missions.

▲ *Search and Rescue helicopter*

▲ *CCG Icebreaker*

Canadian Coast Guard

The MSC and the Canadian Coast Guard (CCG) work together to ensure the safety and security of the marine public and the year-round operation of Canada's marine transportation system. In 2000-01 our Canadian Ice Service (CIS) produced over 5,000 ice charts to enable the CCG to establish safe and efficient shipping routes through ice-covered waters as well as supported search-and-rescue operations. Ice Service Specialists from the CIS spent approximately 1,100 days on CCG icebreakers advising captains about ice conditions affecting the performance and safety of icebreaking and escort activities.

The CCG's Marine Communications System broadcasts our weather and ice information to mariners at sea by radio. We will be working to improve our services to the CCG in the coming year with projects such as an Ice Pilot web page and fact sheet to explain ice codes, products and broadcast schedules.

Highlights of 2000-2001 (con't)

Universities and Research Institutes

The MSC participates in a multitude of cooperative projects with universities and research agencies in Canada and around the world to conduct research on atmospheric and environmental science, and to develop policies on issues such as climate change. Some of our scientists are co-located with universities, such as the University of Toronto, University of Waterloo and University of British Columbia, to serve as adjunct professors and to foster increased synergies between government and academic researchers. The following are examples of our research partnerships.

- The Canadian Foundation for Climate and Atmospheric Sciences (CFCAS) was established in July 2000. The establishment of the Foundation is significant for MSC research and will have a major impact on how we do work in the future. Research proposals submitted under the CFCAS during 2000-01 in which MSC is a partner include:
  - Enhancing climate models by improving representation of the carbon and sulfur cycles, interactions between atmospheric chemistry and climate variables, and atmosphere-ocean coupling;
  - Placing increasing emphasis on smaller scale of climate change predictions and their applications using regional climate models;
  - Increasing the focus on greenhouse gas sources and sinks research in Canada, specifically, in the boreal forest.
- The Canadian Weather Research Program has provided Environment Canada and the MSC with a mechanism for establishing strong partnerships. This Program focuses on improved detection of extreme weather, as well as reducing negative impacts. The Program, formalized in 2000-01, has assisted in the development of partnership proposals for research and development (R&D) with utilities, for a Natural Disaster Research Network with the Insurance Bureau of Canada, and for R&D under our relationship with NAV CANADA.
- The Atlantic Environmental Prediction Research Initiative (AEPRI) is a collaboration among various groups within the MSC (research and operational forecasting), the Department of Fisheries and Oceans (DFO), universities and industry. Multi-disciplinary and multi-stakeholder projects include hurricane and severe marine-weather prediction, atmosphere-wave modelling, and climate change detection and impact studies. The Atlantic storm-surge forecast system, developed under the AEPRI, is just one example of the benefits of this new collaborative approach.

Provinces and Territories

We work with provincial and territorial partners in a variety of areas, including water quantity monitoring, air quality monitoring, agriculture, transportation and forest-fire management.

- The MSC's Quebec region works closely with the Society for the Protection of Forests Against Fire (SOPFEU) by providing meteorological information for use in preparing a daily forest-fire index for central Quebec. A verification system developed with SOPFEU has shown an 88 per cent success rate and a reliability of more than 80 per cent over the last three years. The successful Quebec model was discussed at the last meeting of the Canadian Interagency Forest Fire Committee for possible adoption by other provinces.

- Water level and stream-flow data are collected at hydrometric gauging stations across Canada under formal cost-share agreements with each of the provinces and territories. During 2000-01, real-time data were made available to partners for 155 stations, and an Internet site was developed for launching in 2001-02. Information on the water quantity in our rivers and lakes contributes to our knowledge of changing water levels in the Great Lakes and transboundary water allocations, and assists provinces and municipalities in flood planning and forecasting.

Media

Each year, MSC issues approximately 14,000 warnings of high impact weather, such as severe thunderstorms, tornado and freezing rain, as well as about 500,000 public weather forecasts. Our key partner in getting this information out to Canadians is the broadcast media. The media also assist us in disseminating educational information on how Canadians can protect themselves and their property from hazards such as hail and smog, and longer term adaptation strategies such as how to lower personal emissions of air pollutants and how to reduce health risks.

Hydrometric station ▼

During 2000-01, we continued to build on our relationship with this critical partner, primarily through our contacts in the regions. On a national level, we are working on a specialized web site that will provide the media with specialized products and services suited to their needs. We are also working with national media organizations, such as the Canadian Association of Broadcasters, to agree on standards and mechanisms for the timely dissemination of weather warnings to Canadians.

Private Meteorological Sector

The private meteorological sector in Canada is small, but diverse. MSC is working to build stronger relations with the private sector, and to encourage its growth. A healthy private meteorological sector will benefit all Canadians by increasing economic efficiency and productivity, since $140 billion of Canada's economy is weather-sensitive. To help develop the capacity of the private meteorological sector, we are working to improve data access and to become a catalyst and strategic partner in meteorological ventures. In our Atlantic Region for example, a number of activities were transferred for delivery by the private sector:

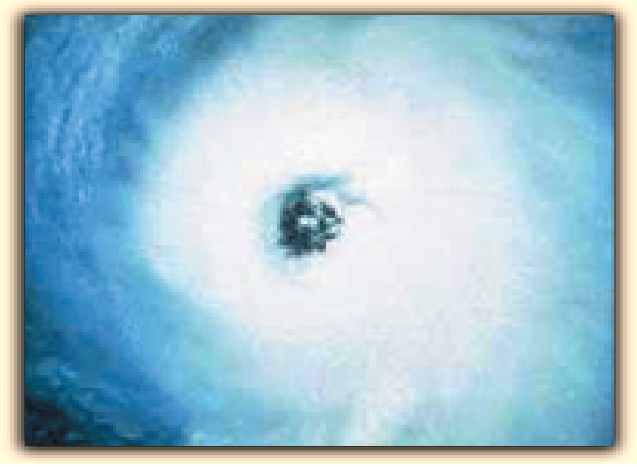
- provision of marine route forecast to high speed ferry service between Nova Scotia and the State of Maine;
- provision of site specific forecasts to various users in the transportation industry;
- consultation requests from the film industry.

3. ADVANCES IN SCIENCE

The MSC conducts research to ensure that Environment Canada has a solid scientific foundation on which to develop policies and strategies to safeguard our environment and protect human health. During the past year, scientists and other staff in MSC regions and headquarters carried out research in a wide variety of areas related to climate change, air quality, weather research and water, publishing reports and articles, and conducting scientific presentations and specialized media interviews in a variety of fields. Following are some examples.

Weather Research

Studies of regional severe weather events like the July 2000 Pine Lake Tornado were conducted in all areas of the country, resulting in an improved understanding of severe weather processes. This research is needed for better weather forecasts, as well as for building improvements into weather prediction models.



Flying into Hurricane Michael

Scientists from our Cloud Physics Research Division flew a Convair aircraft into Hurricane Michael - only the second full-fledged hurricane to make landfall in Canada in 25 years. Michael tore into southern Newfoundland late on October 19, 2000, packing winds with gusts to 172 km/h. While on board the aircraft, the scientists measured winds, temperature structure and the precipitation field of the hurricane.

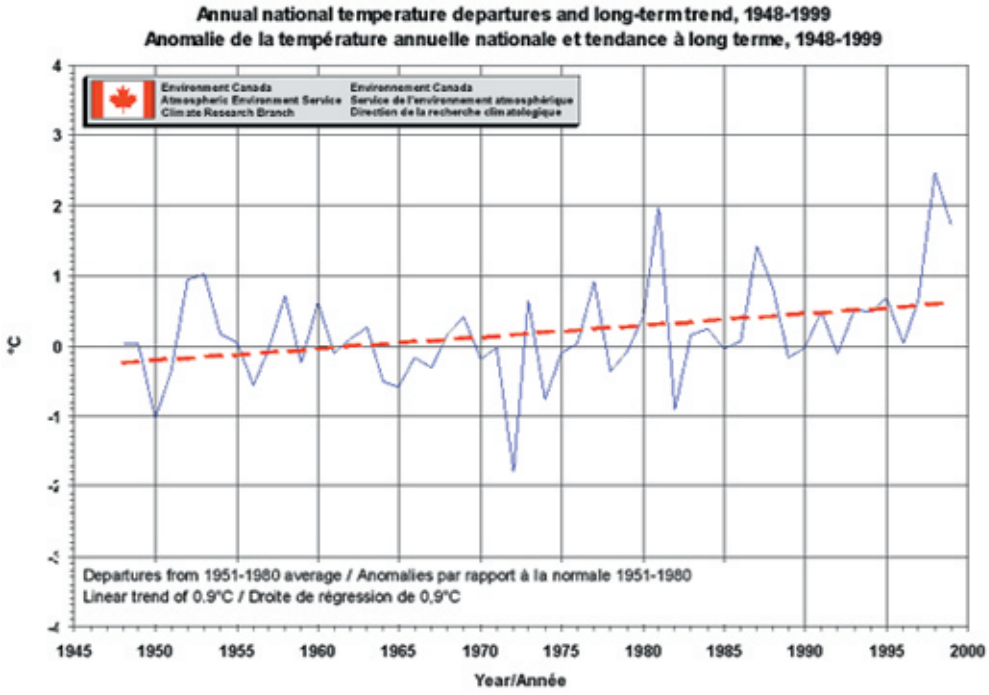
Instruments aboard the craft allowed scientists to see highly magnified images of cloud and precipitation particles of the hurricane. The flight evaluated the potential value of research on the extra-tropical transition of hurricanes for an international hurricane landfall experiment scheduled for the Fall of 2001.

Climate Change Research

Our records indicate that Canada's average annual temperature increased by about 0.9 °C between 1948 and 2000, and by even more in Western Canada. On a global basis, temperatures have risen about 0.6 °C in the past century. In order to help Canadians and the world deal with changes in our climate, our understanding of past and future climate scenarios must be based on credible scientific information.

Canadian General Circulation Models (GCMs), developed over the past decade, are considered among the best in the world. These models predict how the climate and ocean circulation might react to the accumulation of greenhouse gases and other pollutants and thus allow us to develop climate change scenarios. These scenarios help in the development of policies and measures for adapting to climate change.

The prestige and credibility of our models' results was demonstrated in 2000-01, when our GCM was one of two used in the US National Assessment of the Potential Impacts of Climate Variability and Change, and one of the initial four whose results were made available for use by the official

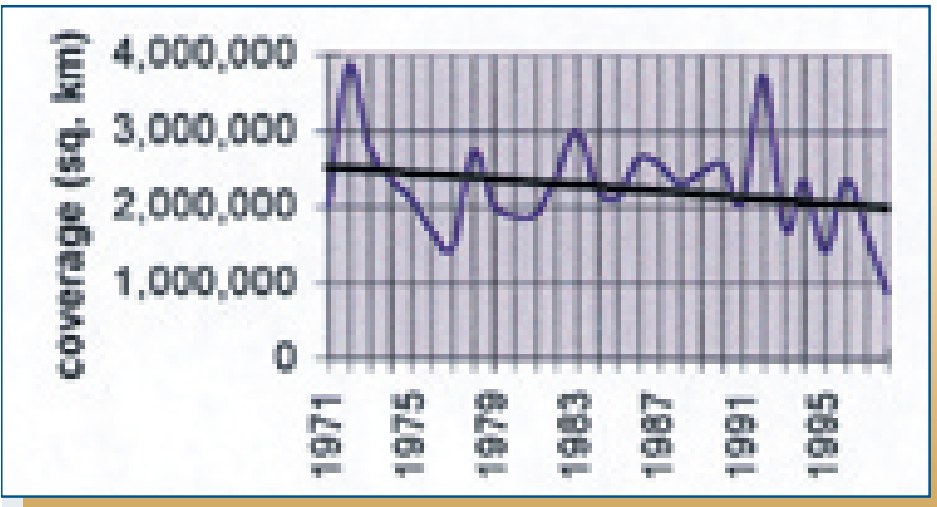


During the past year we produced new runs of the coupled (ocean-atmosphere) GCM for the period 1900 to 2100 using the most up-to-date, internationally agreed-upon emission scenarios, and made these available to users on the Canadian Centre for Climate Modeling and Analysis Web site, which is accessed by hundreds of users each month. The model results are used by scientists, such as those in our Adaptation and Impacts Research Group, to develop strategies and tools to reduce the negative impacts of climate change.

International Panel on Climate Change (IPCC) Data Distribution Centre. Our GCM results were used extensively in the IPCC *Third Assessment Report.*

MSC made a substantial contribution to the preparation of the IPCC *Third Assessment Report* by coordinating the participation of over 30 Canadian scientists. Two of our scientists were lead authors, and others made numerous contributions of time and expertise.

The *Third Assessment* of the IPCC noted that decreasing Arctic sea-ice is a possible indication of global climate change. It remains unclear whether current trends will continue, are just part of natural ice variability, or are a combination of the two. Data collected since 1970s show that the Canadian Arctic has experienced similar decreases in ice extent, although there is considerable regional variation. Since such a decrease could have significant impacts on the people, economy and environment of the Canadian Arctic, our Canadian Ice Service is working to increase its knowledge of long-term climatic ice conditions and the impacts of significant change.

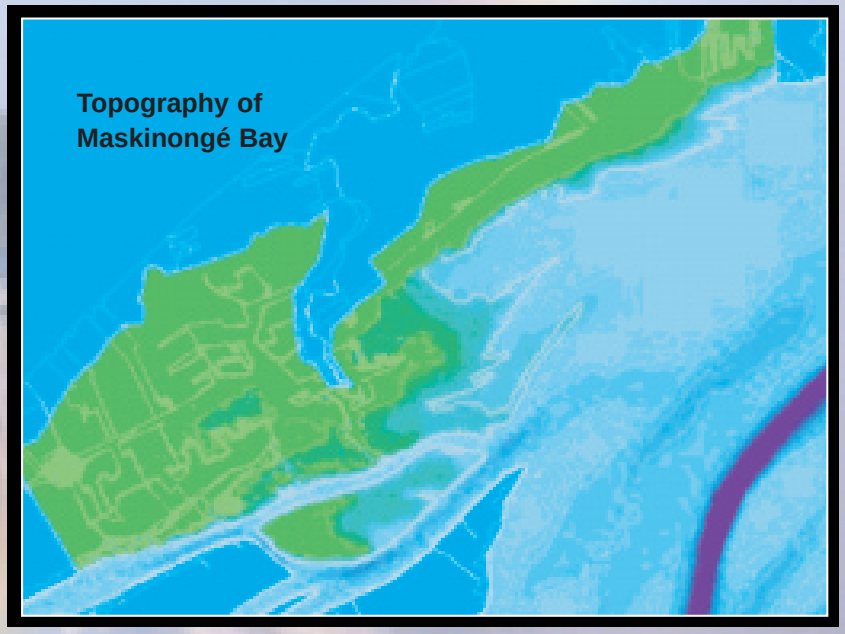


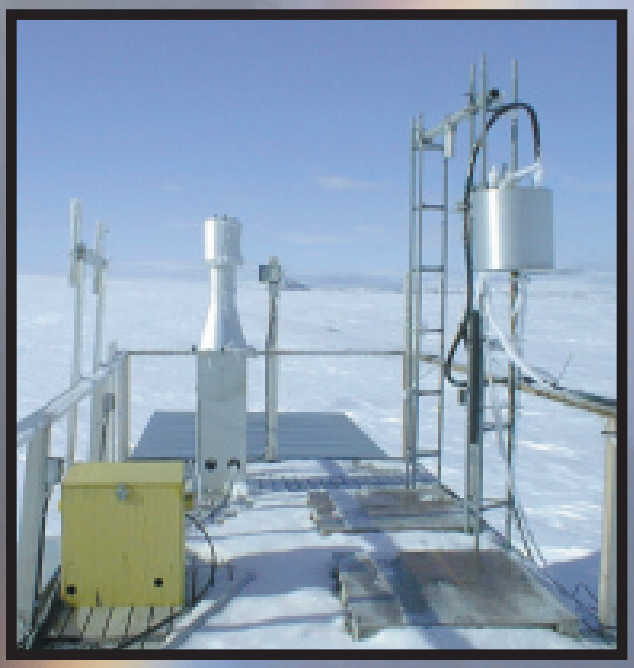
Decreasing sea ice ▲

Highlights of 2000-2001 (con't)

St. Lawrence Numerical Modeling Project

Numerical water modeling of the St. Lawrence River continued over the last year, particularly on the section from the Port of Montréal to Trois-Rivières. The work aims to develop a detailed picture of the shore, flood plain, river bed, substratum type, water depth, waves and current speed, as well as fish habitat and other related parameters. This information will contribute to studies on the impacts of fluctuations in water levels caused by changes in climate or human interventions such as streamflow regulation or dredging. We are conducting this work in partnership with researchers within Environment Canada, other government departments, the province of Quebec, and diverse research institutes.





▲ *Sampling hood located in Alert, Nunavut houses filters that collect particulate mercury compounds from the atmosphere.*

Air Quality Research

In order to improve the quality of our air, we need to first increase our understanding of the type and processes of pollutants in our atmosphere.

Measurements

Measuring pollutants is a key step in this endeavour. During 2000-01, a measurement program for mercury in air and precipitation was successfully implemented across Canada (CAMNet), to complete measurements which have been in place in Eastern Canada for some time. The program included field measurements of mercury and other hazardous air pollutants (HAPs) in utility and smelter plumes, natural emissions of mercury, the emission and transport of pesticides to Canada, and emerging and new chemicals of concern. The data from CAMNet will allow us to monitor the levels of these pollutants and detect any trends in emissions and thus measure the success of reduction strategies.

Modeling

Evidence suggests that Canadian ecosystems are being affected by atmospheric mercury emissions from beyond our borders. To quantify global and regional inputs into these ecosystems, the first phase of a global atmospheric mercury transport model was completed during 2000-01. Model results demonstrated convincingly that mercury is being carried through the air from other countries and thus confirms the need for Canada to work with other countries to address the long-range transport of mercury.

Polar Sunrise Experiment

When the sun rises over the Arctic in March after nearly six months of darkness, its rays stir unexpected chemical reactions at the snow's surface. More than 30 scientists from around the world were in Alert, Nunavut, from February to May 2000 to take part in the largest international study ever conducted of the photochemical effects of the polar sunrise. Fifteen MSC scientists were involved in the field campaign, which focused on ground-level ozone depletion and the potential role being played by chemical reactions in the snow pack and ice surface. The Experiment confirmed the role of bromine in the depletion of ground level ozone during the Arctic Spring, likely due to a transformation of this substance in the snow surface.

Changing the sample cartridge in the high-volume toxics sampler located in Alert, Nunavut

Stratospheric Ozone

Another MSC experiment measured changes in ozone concentration, temperature and aerosols at different altitudes to the upper stratosphere using the MSC lidar at the Eureka Observatory in the Northwest Territories. Essentially all of the atmospheric gases that play major roles in determining the concentration of Arctic stratospheric ozone were measured using various tools which included those developed by the MSC and the University of Toronto.

Highlights of 2000-2001 (con't)

▼ *Eureka stratospheric ozone laboratory on Ellesmere Island in the Canadian Arctic*

Hazardous Air Pollutants (HAPS)

Revised loading estimates of HAPs to the Great Lakes were reported this year as part of a joint Canada/US measurement program in the Great Lakes Basin. The report describes changes in the deposition of various chemicals for each lake and demonstrates that, for some chemicals, the lakes are now a source rather than a sink, signaling a recovery in the Great Lakes water quality.

▲ *EC01 is a large environmental buoy used to measure the flux of HAPs to and from Lake Ontario*

Particulate Matter (PM)

Particulate Matter consists of tiny airborne particles that can penetrate deep into the lungs and pose a significant risk to human health. PM comes from both natural sources, such as forest fires, and human sources, like factory and vehicle emissions. PM is also formed indirectly through chemical reactions in the atmosphere (secondary PM).

During 2000-01 MSC prepared a state of understanding report on precursor gas contributions to secondary particulate matter (PM) in Canada. The report addresses the current understanding of PM formation mechanisms from precursors, source-receptor relationships, and the importance of primary emission sources versus the secondary formation of PM in the atmosphere. This report provides a strong scientific basis for developing implementation plans for Canada-wide Standards for $PM_{2.5}$ (particles less than 2.5 micrometres in size), and discussions of ammonia toxicity under CEPA (the Canadian Environmental Protection Act). It also provides key scientific background to the public for the discussion of PM Precursors and Ozone and Precursors under the CEPA.

4. HUMAN RESOURCES

A dedicated and highly trained scientific and technical staff have earned the MSC an international reputation as a world-class meteorological prediction service and leader in atmospheric science research. Our staff work in every region of the country—and many of them in round-the-clock shifts—to monitor and predict weather events and sea ice conditions, and measure changing water levels in major lakes and rivers.

▲ *Taking a weather observation in Eureka*

Recruitment of Meteorologists

Early in 2000, after a hiatus of several years, we re-established our training program for new meteorologists. Thirty-seven students graduated from courses held in Edmonton (Alberta), Dartmouth (Nova Scotia), and Montréal (Québec), after completing an intensive six-month session in theory and simulation, followed by a period of on-the-job training.

Courses will now begin in September and run until March, once again putting the recruitment and training cycle back in synch with the school year. University enrollment in meteorology—which was down significantly during the years when we were not hiring—has begun to grow since we stated our intention to hire at least 20 new meteorologists a year in the foreseeable future.

Training

A two-week workshop on severe winter weather was developed in partnership with Canadian and US scientists from government and universities. The pilot program was delivered to 16 MSC forecasters at the US National Centre for Atmospheric Research Co-operative Program for Operational Meteorology Education and Training (COMET) facility, in order to improve their capability to predict severe winter weather. Future partnership opportunities between the MSC and COMET are being considered under the Canadian Weather Research Program's professional development program.

Graduates of the first MSC-COMET winter forecasting course ▶

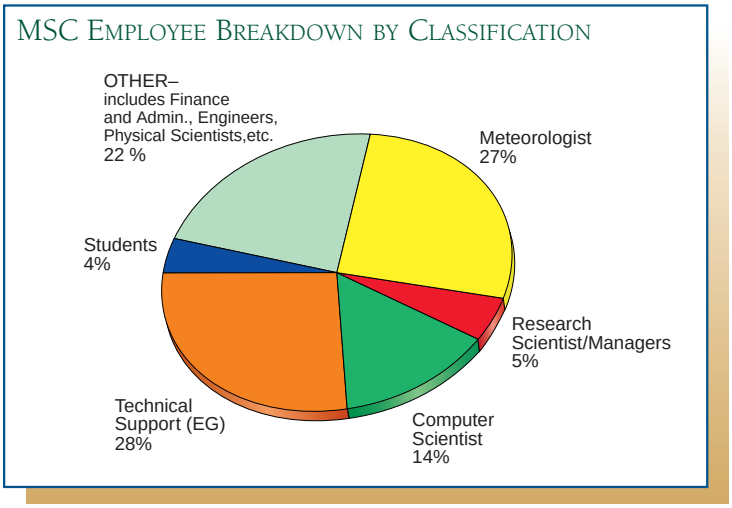
Highlights of 2000-2001 (con't)

In an effort to transfer research results to the operational prediction and policy programs, ten three-day workshops on environmental prediction were delivered across the country to regional Environment Canada scientists and their partners.

Awards

Numerous Citations of Excellence and other awards were presented to MSC staff during 2000-01 in recognition of a wide range of accomplishments. The Service's highest award—the Jim Bruce Achievement Award—was presented to Gordon McBean, former Assistant Deputy Minister of MSC, and Louise Kindree, a long-time human resource advisor, in recognition of their contributions.

The National Aeronautics and Space Administration (NASA) Aircraft Icing Team, which includes several MSC employees, won NASA's Revolutionize Aviation Goal award this year for its work in the field of aerospace technology. The project manager of Aircraft Icing at the NASA Glenn Research Center said the team would not have won the award had it not been for the MSC's efforts in the field of icing.

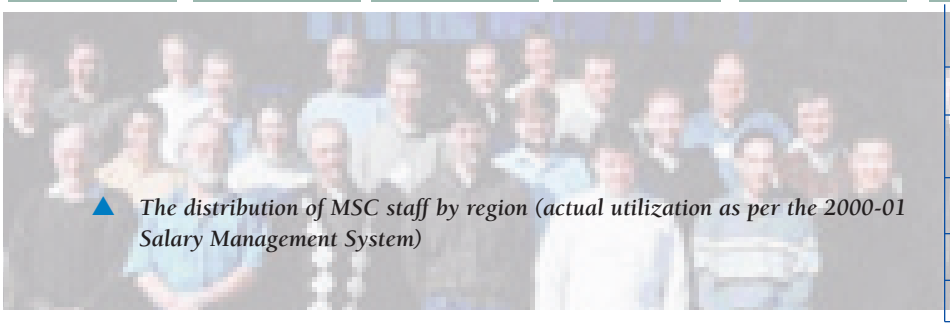


▲ *The breakdown of the various types of employees in the MSC, by category*

In June 2000, our Canadian Meteorological Centre (CMC) received special recognition from the US National Weather Service (NWS) for providing emergency assistance following a serious fire in September 1999 at the NWS supercomputer infrastructure. The CMC used model outputs and provided specialized forecast products until mid-January 2000.

Employees (Full Time Equivalents) by Region

ATLANTIC	QUEBEC	ONTARIO	P&N	P&Y	MSC HQ	TOTAL
127	151	178	351	199	822	1828



▲ *The distribution of MSC staff by region (actual utilization as per the 2000-01 Salary Management System)*

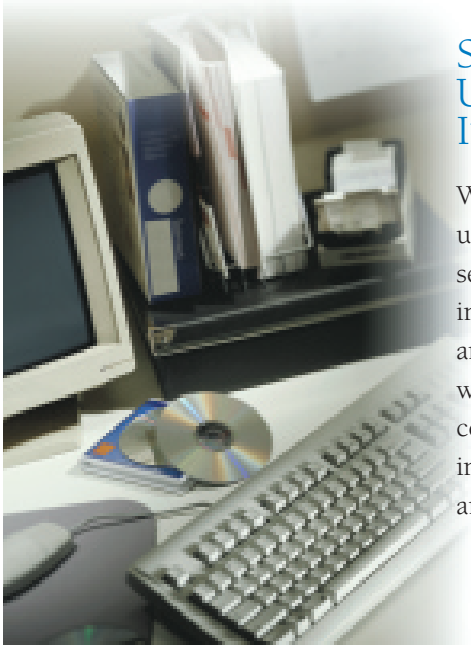
ADMA and National Funds	5
Policy and Corporate Affairs	28
Atmospheric Monitoring and Water Survey	106
Services, Clients and Partners	200
Atmospheric and Climate Science	280
Atmospheric Environment Prediction	203

5. TECHNOLOGY

The MSC is one of the most automated weather and hydrometric services in the world, with a $375 million technological infrastructure. This infrastructure ranges from traditional (thermometers and rain gauges) to state-of-the art technology (supercomputers, Doppler radar, satellite receivers), and must operate 24 hours a day, 365 days a year. The following describes some advancements related to technology during 2000-01.

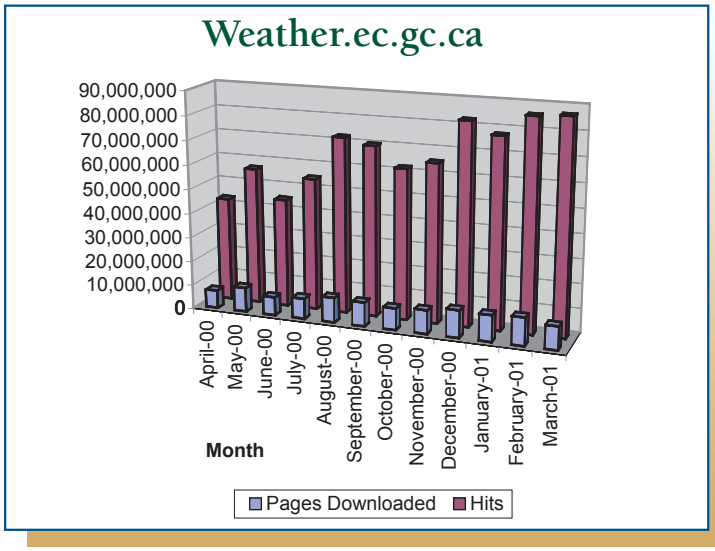
Internet Workshop on Wind Chill

In April 2000, the MSC hosted more than 400 participants in an international workshop on wind chill, held entirely over the Internet. This "virtual" conference sparked vigourous discussions from scientists around the world as well as from the general public and the media. The on-line workshop was the first of its kind for Environment Canada, and demonstrated an innovative use of technology to gather ideas and opinions in a convenient, economical and environmentally friendly manner. As a result of this workshop, an improved wind chill index, based on sounder science and public expectations, is being developed for implementation in the fall of 2001.



Service Delivery Using the Internet

We are making increasing use of the Internet to deliver services and provide information to Canadians and scientists around the world. Our web sites contain information about impacts on human health and safety from weather related hazards, air quality, pollen, acid rain, atmospheric mercury, stratospheric ozone depletion, and ultraviolet radiation. Real-time weather forecasts are also provided on line, and new products, such as live radar images, have been added to improve information—particularly during extreme weather events.



▲ *Chart of hits and pages downloaded on weather web site*

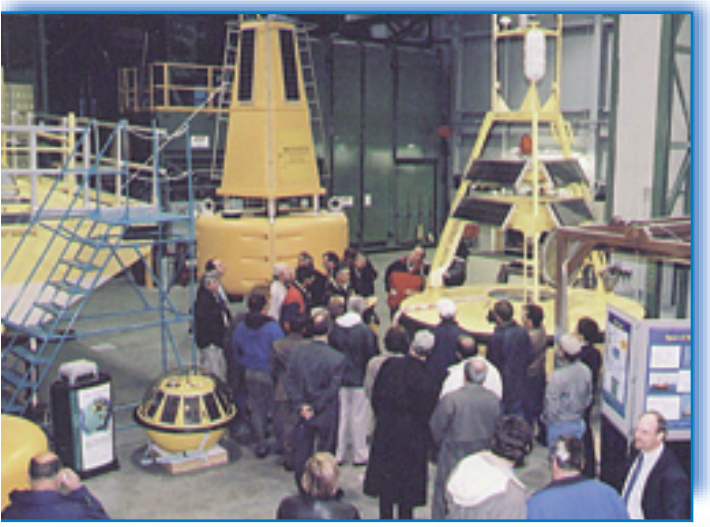
During 2000, the maintenance of our real-time weather web site was shifted to the Canadian Meteorological Centre in Dorval, Quebec, to ensure 24-hour support, seven days a week, more powerful hardware, and higher bandwidth. This more robust infrastructure means that we are much better equipped to handle the peaks in demand that occur during extreme weather events. The popularity of our web sites continued to rise. For example, use of the real-time weather site increased from about 50 million hits in January 2000 to over 80 million hits in December 2000 (see chart). In summer 2001, MSC's site will be changing to a new address: weatheroffice.ec.gc.ca.

Highlights of 2000-2001 (con't)

Data Monitoring and Acquisition

Data are critical to predicting future states of the environment. We have an array of networks across the country that collect weather, air quality, ice, snow and water observations from the earth's surface, atmosphere, bodies of water, and even from space. We share these data with others in Canada and with over 179 countries around the world. With continuous and systematic observations of the atmosphere, hydrosphere and cryosphere, Canada and other countries can examine and understand the environment, predict how it will change, identify trends and evaluate options for policy development.

During 2000-01, our scientists participated in and chaired international working groups on data monitoring and collection issues, such as automated weather stations and cooperative climate programs, and provided technical expertise in such areas as hydrology.



▲ *Delegates tour buoy maintenance facility in Victoria, British Columbia*

▲ *Downloading hydrometric data*

Buoy Network

Canada operates the second largest data buoy network in the world. In April 2000, our Pacific and Yukon region hosted the annual meeting of the International Data Buoy Cooperation Panel—a network that shares data collected from moored and drifting buoys and of which the MSC is an active member.

Network Modernization

During 2000-01, we developed plans to modernize some of our data collection networks, such as those dealing with climate, surface weather, hydrometry and air quality. We replaced or retrofitted critical equipment that was past its life span or that presented health and safety risks to staff.

The modernization of Ontario's hydrometric stations was completed, along with a five-year replacement program for manometers. One hundred twenty-one contaminated hydrometric sites were assessed and remediated across our Prairie and Northern region, with over 200 sites

completed across Canada. Two warehouses in Yellowknife, Northwest Territories, and Winnipeg, Manitoba, were similarly assessed and remediated.

Prototype equipment was developed to make taking water measurements safer for staff—including a remote-controlled boat and a remote-controlled cableway flow measurement system.

AMDAR

The meteorological community has long benefited from weather reports radioed by pilots. However, these reports are voluntary, irregular and prone to error as they are orally relayed. Recently, technology has been developed which enables observations to be collected automatically from planes in the air and relayed for use in weather models (Aircraft Meteorological DAta Relay or AMDAR). Aircraft carriers have begun transmitting data at a rate of over 100,000 reports daily, and the Canadian Meteorological Centre has started to use these data operationally. Although none of the carriers currently sending information are Canadian, we are working to develop a Canadian AMDAR program and software has been developed for smaller (Dash-8) regional airplanes.

Forecast Production Systems

2000-01 saw our Canadian Meteorological Centre (CMC) making improvements to forecast production systems and models. This included better use of data from sources such as automated aircraft observations and satellites, and the improvement of wind-speed and precipitation forecasts in certain areas. Work on SCRIBE, a forecast text generator, will result in a more diversified set of user-tailored forecast products. A statistical software application developed by the CMC (Updateable Model Output Statistics or UMOS), was implemented to make better use of increasingly detailed forecast outputs. During developmental testing, temperature forecasts showed a striking improvement.

▲ *Canadian Meteorological Centre in Dorval*

Selected Performance Information

The MSC has a long history of measuring performance, in both the operational and the client satisfaction domains.

Operational Measures

A variety of technical verifications of weather warning and forecast accuracy are carried out on a regular basis to evaluate our performance and to ensure a high standard of service to Canadians.

Aviation Performance Measurement

As part of our contract with NAV CANADA, we developed a world-class performance monitoring system for aviation weather services. This system has been working non-stop for five years, and currently has four servers running 24 hours daily, seven days per week, monitoring information at 213 airports, with 6000 files produced per day. In accordance with our contract with NAV CANADA, we report quarterly on the performance of our Terminal Aerodrome Forecasts and other key indicators.

Warning Verification

Work is under way to develop a system for monitoring the performance of our public warning program based on the successful aviation performance measurement system. The public warning system will focus on performance targets related to the timeliness of weather warnings for different types of severe events. The system design was completed in 2000-01, and progress was made on software development and preliminary quality control measures.

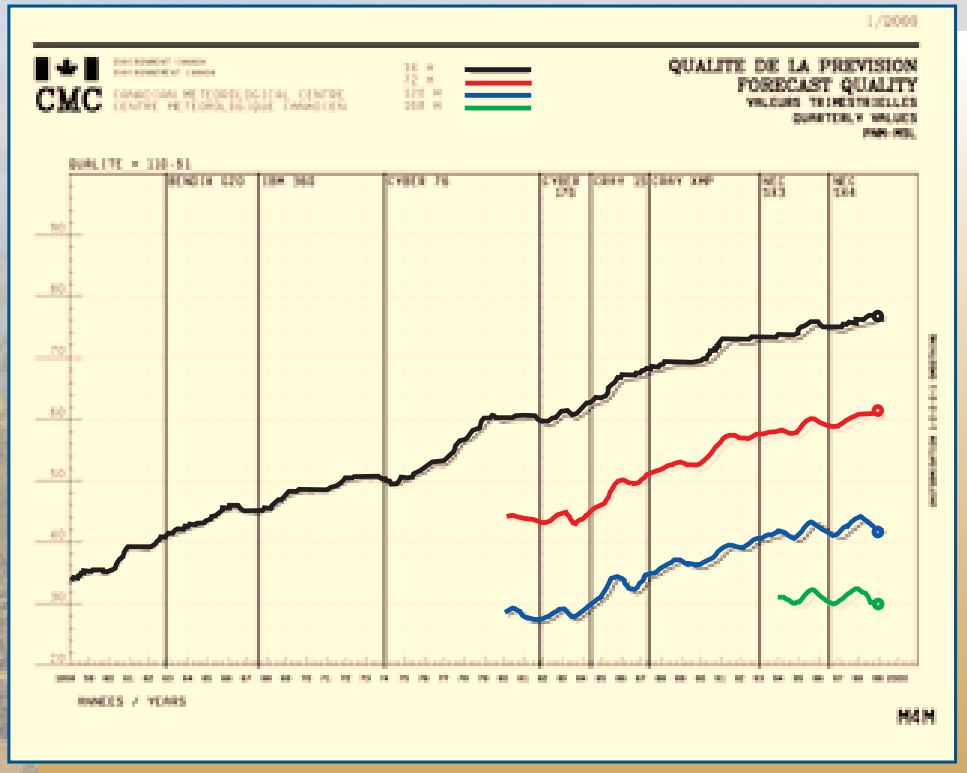
Canadian Meteorological Centre (CMC) Production System

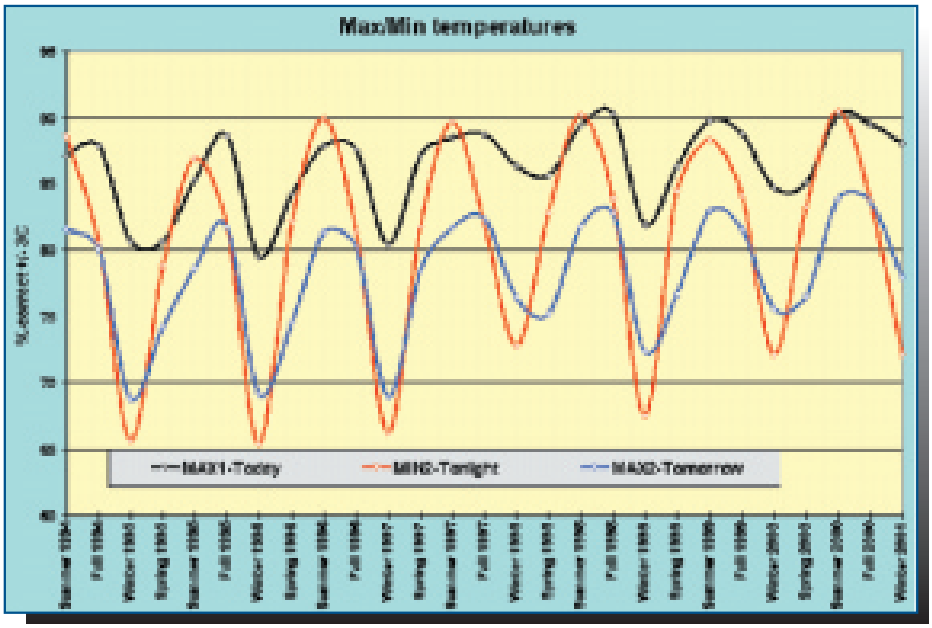
The CMC operational production system and the infrastructure that supports it (hardware, telecommunications, and the CMC building) have a high level of reliability, and are continuously monitored. In 2000, very few problems were experienced with the system, which was assessed as 97.8 per cent reliable based on strict criteria. Overall, there were only 16 cases where problems caused delays of 10 minutes or more to the regional or global runs, and only two cases of delays of more than one hour.

Verification of Numerical Models and Weather Element Forecasts

CMC conducts verification of aspects of operational performance, including the error rate of our models and accuracy of temperature and precipitation forecasts. A good sample of such verification can be found at: http://www.msc.ec.gc.ca/cmc/verification/index_e.html.

The graph below provides a good indication of how our forecasting system has improved over the years. The forecast quality index, calculated for the Canadian Region, is based on the S1 score for the surface





Max Min Chart

The graph depicts the % of the time that the forecast temperature is correct to within 3°C of the actual temperature. Over the past 6 years, forecast accuracy has increased for daytime maximum temperatures, especially during late winter and springtime. Winter minimum temperatures have improved but less so.

pressure, which measures the proper positioning of large scale weather systems.

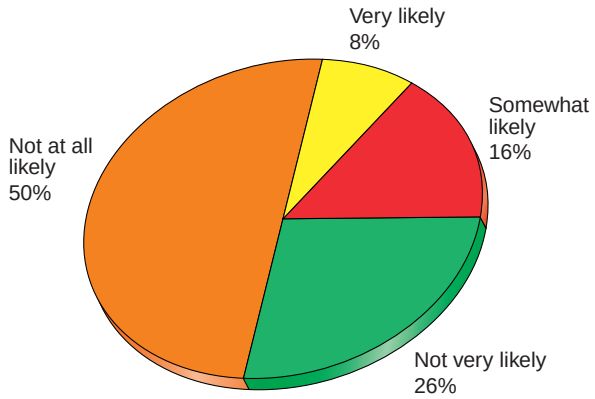
Client Satisfaction Measures

We regularly conduct focus groups and surveys of key clients, particularly the general public, to assess the effectiveness of our programs. We use the results to ensure that products and services meet public and client needs and expectations and to determine if changes or improvements are required. Surveys conducted in 2000-01 include:

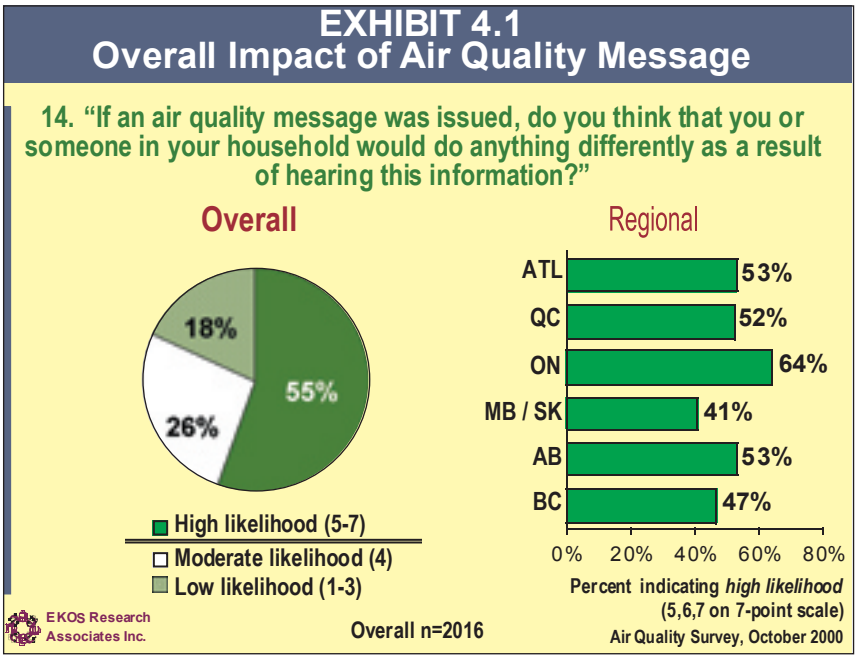
Weather Information on the Internet: A national public survey was conducted on public usage of weather information on the Internet. The survey revealed that, while television and radio are still the main methods of obtaining weather information, the Internet is growing in usage as both a primary and alternate source of such information. Environment Canada's Internet sites receive the greatest recognition in terms of usage, format, presentation, and reliability among those who currently use the Internet to find weather information.

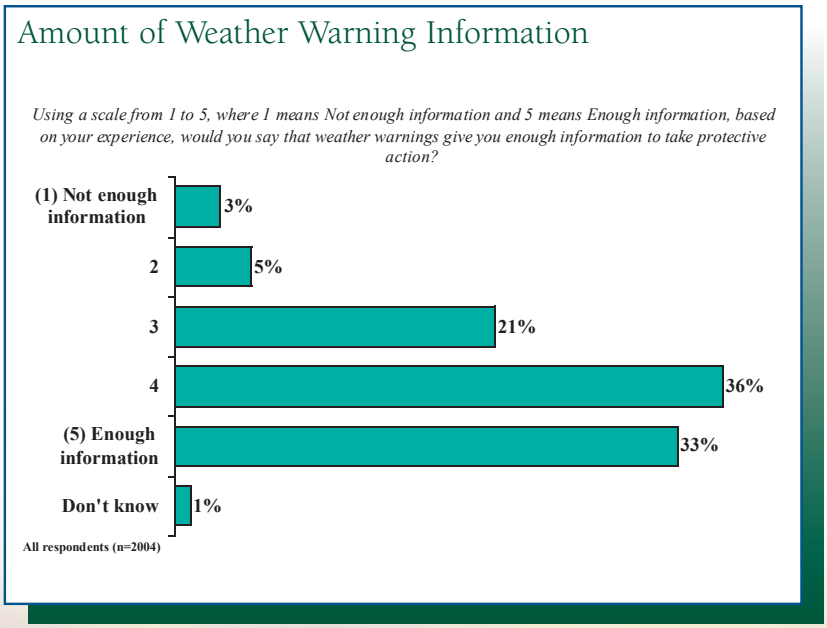
LIKELIHOOD OF USING INTERNET FOR WEATHER INFORMATION IN THE FUTURE

Q10 – How Likely Would It Be That, in the Next 12 Months You Will Begin Using the Internet to Look for Local Weather Information?



Air Quality Information Services: A national public opinion survey on awareness and attitudes towards air quality information services was conducted as part of our contribution to the Clean Air Program. Overall survey results indicated a high level of support for air quality prediction information—with 92 per cent of respondents expressing a desire for such information year-round. There was also moderate interest in both particulate matter forecasts and winter air pollution information. Respondents said they would be likely to change their behaviour based on air quality messages (see graph).





Polling on Weather Warnings: During winter 2001, several public opinion projects were conducted on public awareness and behaviour regarding weather warnings. They found that an overwhelming number of Canadians rely on the media—particularly television and radio—for warning information, and are generally satisfied with this method. Respondents stated that they feel knowledgeable about what to do in the case of a warning, and find the information provided sufficient for them to take protective action.

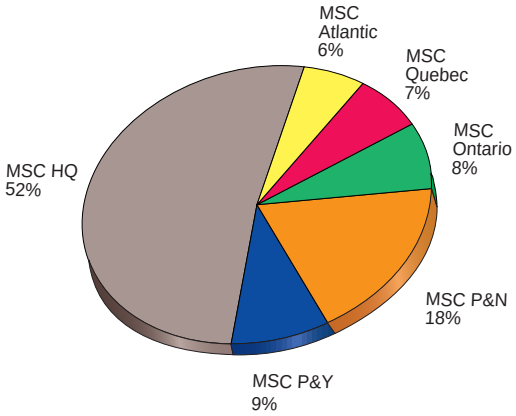
Other Feedback Methods

Performance is also measured through other feedback methods, such as 1-800 numbers and Internet contact mechanisms. There were approximately 8000 enquiries sent to MSC via our various web sites last year. A national 1-800 feedback line was launched in 2000 to provide another means for Canadians to voice their concerns or pose questions.

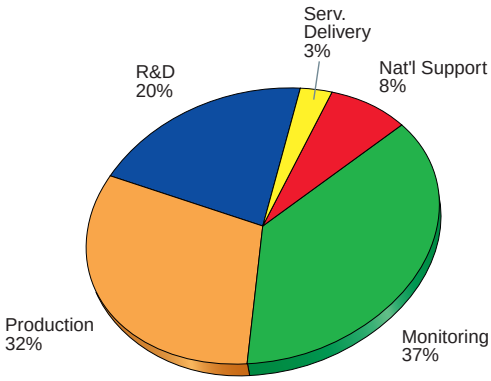
Selected Financial Information

Spending and Revenue in 2000-01

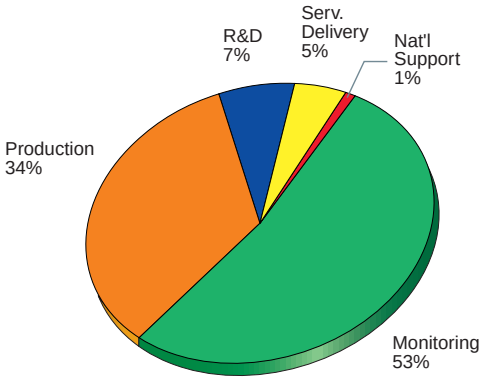
MSC Organization Total Expenditures 2000/01



MSC Expenditures By Function



MSC Revenue By Function



TOTAL MSC RESOURCES BY INPUT FACTOR (in thousands)

	Salary		Employee Benefit	O&M		Capital		Grants and	
	Appropriation	Revenue	Plan	Appropriation	Revenue	Appropriation	Revenue	Contributions	Total
Atlantic	6,437.5	179.8	1,290.4	1,807.9	2,716.1	0.0	0.0	0.0	12,431.6
Quebec	6,024.6	5.9	1,175.9	2,461.3	2,296.0	341.3	0.0	200.0	12,505.0
Ontario	7,393.6	112.8	1,466.1	2,823.9	4,195.1	471.4	0.0	0.0	16,462.8
P&N	15,787.8	43.9	3,090.4	9,752.0	5,384.9	596.5	0.0	0.0	34,655.3
P&Y	7,599.6	1,079.1	1,692.4	3,320.6	3,563.5	298.7	645.0	0.0	18,198.9
MSC HQ	36,021.5	15,908.8	10,126.5	31,789.8	32,982.4	18,040.0	1,300.0	5,060.0	151,229.0
Total	79,264.5	17,330.3	18,841.5	51,955.4	51,137.9	19,747.9	1,945.0	5,260.0	245,482.6

Photo credits

Cover	*MSC Supercomputer: Canadian Meteorological Centre (CMC)*
Cover	*RADARSAT -1: Canadian Space Agency*
Cover	*High volume sampler for aerosols (Alert, Nunavut): C. Blanchette, MSC*
i	*Lightning: MSC Quebec region*
i	*Quebec Hydro pylons: M. Chamberland, La Presse (from Le Grand Verglas)*
ii	*Satellite image: NOAA (NESDISS)*
iii	*MSC ADM*
v	*David Anderson*
vi	*Ice infested waters: Canadian Ice Service*
1	*MSC HQ in Downsview: V. Hudec, MSC Downview*
2	*Climate Research Branch snow technician: M. Davey, MSC Downsview*
3	*Military Ship: Department of National Defence*
3	*Ozone sonde balloon: MSC Experimental Studies Division*
4	*Tornado: P. McCarthy, MSC PNR*
4	*Storm Surge Damage PEI: K. MacDonald, EC Atlantic region*
5	*Iceberg: Canadian Ice Service*
5	*Weather Radar Installation: MSC National Radar Project*
6	*RWIS sensor: P. DeLannoy, MSC*
6	*Smokestack: stock photo*
8	*NAV CANADA Flight Services Specialist: NAV CANADA*
9	*Military ship: Department of National Defence*
9	*Search and Rescue Helicopter: Department of National Defence*
9	*CCG ship: Canadian Coast Guard, Department of Fisheries and Oceans*
11	*Hydrometric Station: D. Forlanski, MSC PNR*
12	*Hurricane photo: NOAA*
13	*Stormy sky: P. McCarthy, MSC PNR*
14	*Sampling Hood: Carbon Cycle Research Laboratory*
15	*Toxics sampler, Alert: C. Blanchette, MSC Downsview*
16	*Eureka: Experimental Studies Division, MSC Downsview*
16	*EC01 buoy: K. Puckett, MSC Downsview*
17	*Eureka weather observer: R. LeCoty, MSC Eureka (PNR)*
17	*COMET class photo: courtesy of COMET*
19	*Desktop: stock photo*
20	*Buoy tour photo: AXYS Environmental Systems.*
20	*Downloading hydrometric data: H. Aucoin, MSC Downsview*
21	*CMC Dorval: Doug Bender, CMC*
21	*Lightning: P. McCarthy, MSC PNR*
24	*Stormy sky: P. McCarthy, MSC PNR*
26	*Lightning: MSC Quebec region*

For more information or copies of this document, please contact:

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Or visit our web site: www.msc-smc.ec.gc.ca

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