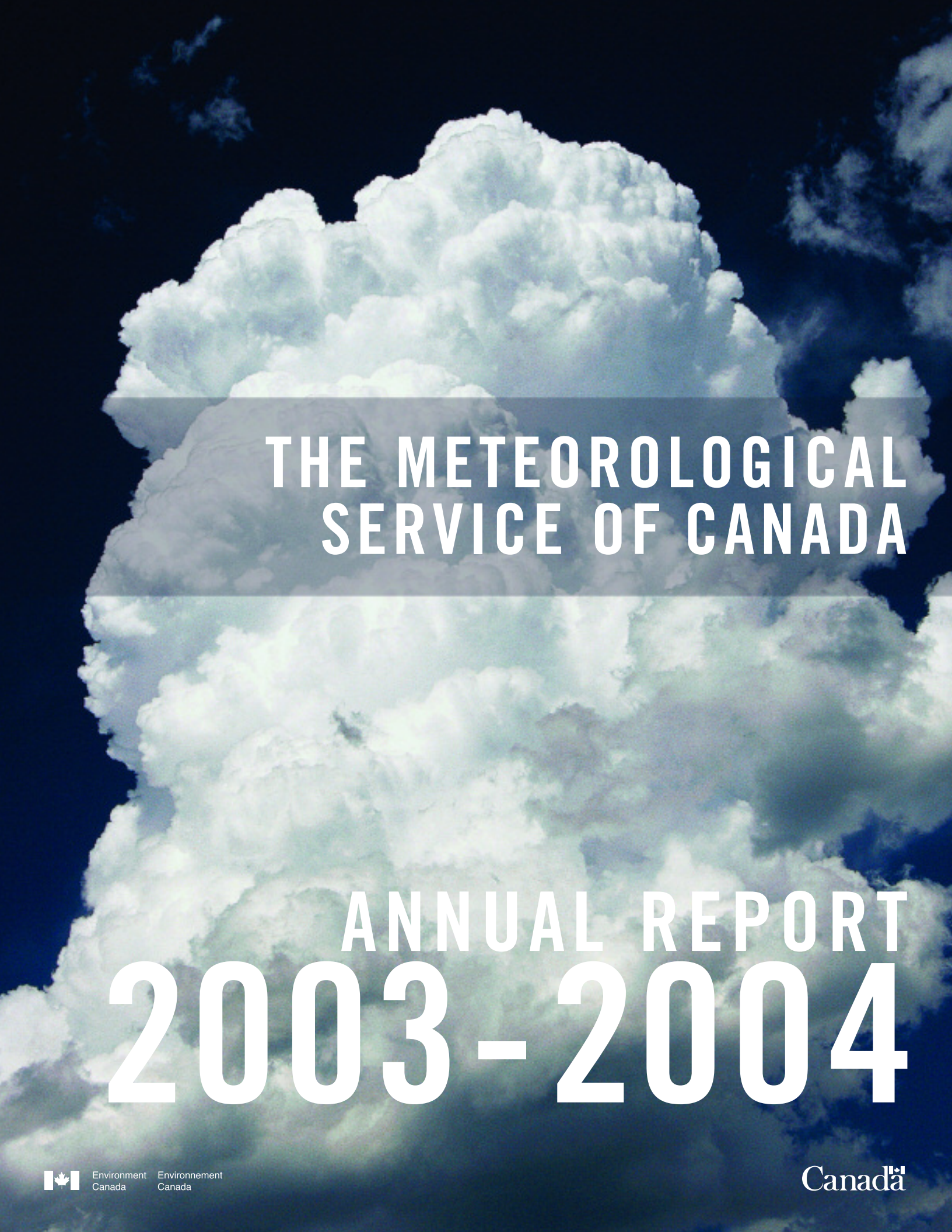

THE METEOROLOGICAL SERVICE OF CANADA

ANNUAL REPORT 2003–2004

Environment Canada Environnement Canada

Canada

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MESSAGE FROM THE MINISTER

As the new Minister of the Environment since July 2004, I would like to report that I am proud of the accomplishments of the MSC and its staff during 2003-2004.

In 2003-2004, Canadians from coast to coast experienced a year of non-stop weather disasters. From forest fires in British Columbia, which caused the second largest evacuation in Canadian history, to Hurricane Juan, which battered the East Coast and felled 100 million trees as it tore across Nova Scotia and PEI, 2003 was one of Canada's most extreme and expensive years for weather-related disasters.

Fortunately, Canadians had ample warning of these, and thousands of other severe weather events in 2003 due to the vigilance, dedication and professionalism of the staff at the Meteorological Service of Canada, who serve Canadians 24/7, 365 days a year.

However, weather forecasting is only a small part of the work that is done by the 2 000 employees of the MSC. Aside from meteorologists, the MSC employs hundreds of scientists, technicians, researchers, and analysts who work to support Canada's environmental priorities, including clean air, water supplies, and climate change.

MSC staff carried out important work related to each of these priority areas in 2003-2004. They contributed their expertise to the development of *Threats to Water Availability in Canada*, a national study that identifies threats to Canada's freshwater sources, and highlights the need for action on many fronts to ensure Canadians' future access to adequate supplies of clean, safe and secure freshwater.

The study also identifies climate change as one of the threats to Canada's sources of freshwater. MSC scientists study many of the effects of climate change and were instrumental in producing *Climate, Nature, People: Indicators of Canada's Changing Climate*, a report issued by the Canadian Council of Ministers of the Environment in 2003. The report describes changes to Canada's climate during the 20th century and to 12 indicators and suggests that the climate in many regions of Canada is changing.

The MSC is also making important contributions to three pilot projects under the Border Air Quality Strategy that was announced with the United States in June 2003. These projects build on earlier cross-border initiatives that are reducing acid rain and smog-causing pollutants, and helping to strengthen Canada-U.S. relations. The MSC continues to advance and improve the National Air Quality Forecast Program as well.

I encourage you to read the MSC 2003-2004 annual report to learn more about these and other exciting initiatives that continue the proud tradition of excellence that the Meteorological Service of Canada has been building since 1871.

The Honourable Stéphane Dion, P.C., M.P.
Ottawa, Ontario

MESSAGE
FROM THE DEPUTY MINISTER

Although I joined the department after the end of year 2003-2004, I would like to take this opportunity to convey my appreciations for the incredible contribution MSC and its staff are making to the safety and well being of Canadians. This contribution was also recognized by the federal government by providing new funding for the modernization of the MSC.

This first year of transition towards the revitalization of the MSC was also characterized by a series of severe weather, the primary focus of the MSC for the protection and safety of Canadians. Despite all the work being done on transition, MSC staff pulled together and put their professional skills into serving Canadians where it matters the most: saving lives and reducing property losses. In British Columbia, timely updates of meteorological information provided by our staff, some of whom suffered home losses or damages, helped firefighters evacuate residents and contain the forest fires. Hurricane Juan, the worst hurricane to hit Atlantic Canada in over 100 years with estimated damages near $150 million, was accurately predicted by MSC staff at the Canadian Hurricane Centre in Halifax, allowing residents and emergency measures organizations to take appropriate safety actions. In fact, heavy rain and high winds were predicted nearly three days ahead of time. The media were notified, more than 15 hours before landfall, that Hurricane Juan would be the worst hurricane to hit Nova Scotia in at least 40 years.

Much of the work of the MSC depends on the availability of data gathered by satellites, radars, ocean buoys, weather balloons and fixed weather stations. These earth observations provide the tools to take the pulse of our planet and are critical in understanding the Earth. Through the MSC and other federal departments, Canada is a committed partner in the international Group on Earth Observations (GEO) that is developing a ten-year plan to collect and analyze information on the environment, the atmosphere and our oceans more efficiently on a global scale.

As a department, we are now embarking on a collective reflection on a path forward to even better serve Canadians in all areas related to environment. The MSC, which holds the only federal Department Service Organization (DSO) status, is one of the key players in shaping this new direction. We will continue to build on the MSC's successes which you will discover in reading this report.

Samy Watson

FOREWORD
FROM THE ASSISTANT DEPUTY MINISTER

I would like to take this opportunity to sincerely thank our staff for their continuing dedication during this challenging period of the MSC transformation. 2003-2004 was the first year of transition towards a revitalized MSC. It was a critical year in terms of moving the MSC to where we want to be in five years. Much work was done to steer us towards our future. Many MSC staff contributed to these efforts and I am pleased to report that we are making significant progress.

- we began consolidation of aviation activities into two aviation centres in Edmonton and Montreal to better serve NAV CANADA, one of our major clients and partners;
- we developed charters for our National Service Offices and have initiated the staffing process to move employees to their new jobs to tackle new challenges;
- we continued the installation of Doppler radars with the last one (the 31st) scheduled to be operational in 2004-2005;
- we have done tremendous work on the installation and testing of the new IBM supercomputer that will allow us to run our models at higher resolutions for more accurate forecasts and to push the boundary of research in climate change, and;
- we have made improvements to our monitoring infrastructure with the modernization of 21 climate and 14 surface stations and the deployment of new emergency response portable upper air systems in the regions. In addition, the installation of Acoustic Current Profilers allowed Canada to be amongst the world leaders in terms of national implementation of hydroacoustic technologies for water quantity monitoring.

We consulted with the private meteorological sector in an effort to understand each other and to pave the way for future collaboration. We also developed guiding principles to govern our relationship with this sector. These initiatives led to a number of joint ventures, including the establishment of a consortium to better position value-added meteorological services in the global market.

Partnerships are essential to the delivery of our programs. In 2003-2004, we signed an agreement with Health Canada for radiological monitoring for the safety of Canadians. We also agreed to collocate our new service unit in Regina with the new National Agro-climate Information Service of Agriculture and Agri-Food Canada, in an effort to optimize federal government services to the agricultural sector.

The MSC annual report highlights these accomplishments and many more. While the road toward completion of our transition is still long and full of new challenges, I am confident that our dedication, professionalism, talent and hard work will ensure our success.

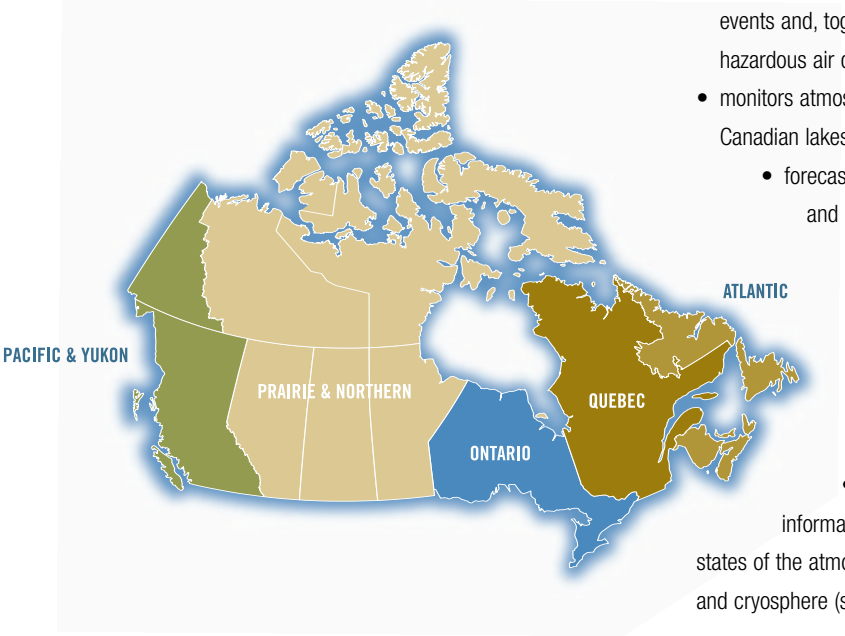
Marc Denis Everell

I. WHO WE ARE AND WHAT WE DO

The Meteorological Service of Canada (MSC) was created in 1871 as one of the early acts of the new Government of Canada. That decision recognized the importance of weather information for Canadians. Over time, the scope of the MSC's work has grown. For example, monitoring of fresh water levels was first officially recognized in 1908; two world wars and the global growth of the aviation industry created the need for provision of specialized weather information to that sector. In addition, air pollution and associated health concerns gave rise to the need for forecasts of air quality.

These important modern responsibilities and continually evolving Canadian needs provide the MSC with the impetus to continually look forward. The MSC is always working to maintain clear plans that will enable us to rise to the challenges of the future.

ENVIRONMENT CANADA'S REGIONS



Today, the MSC is a Departmental Service Organization within Environment Canada that:

- provides weather forecasts and warnings of high-impact weather events and, together with the provinces, produces information on 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;
- leads the development of atmospheric science and related environmental prediction in Canada;
- is at the source of every weather warning in Canada; and,
- is the principal scientific authority for standards, information and advice on the past, present and future states of the atmosphere, hydrosphere (lakes, rivers and oceans) and cryosphere (snow and ice).

The MSC mission statement is a summary of our work:

HELPING CANADIANS ADAPT TO THE INFLUENCES AND IMPACTS OF ATMOSPHERIC AND RELATED ENVIRONMENTAL CONDITIONS ON HUMAN HEALTH AND SAFETY, ECONOMIC PROSPERITY AND ENVIRONMENTAL QUALITY.

The MSC has many facets:

- Approximately 2 000 staff members, many of whom are specialized scientific and technical workers. Many work round-the-clock shifts on land and at sea in locations across Canada, including the High Arctic, to monitor and predict weather and ice conditions, to measure water levels of major lakes and rivers and to compute river flow quantities. Our dedicated staff is the primary reason the MSC is recognized internationally for world-class weather prediction services and excellence in atmospheric science research.
- One of the most sophisticated weather and hydrometric services in the world, with a $336.7 million technological infrastructure that operates 24 hours a day, 365 days a year. This infrastructure includes everything from traditional tools, such as rain gauges and thermometers, to state-of-the art supercomputers, Doppler radars and satellite receivers.
- A research laboratory and a large component of the MSC's national headquarters located in Toronto.
- Weather centres in MSC's five regions, providing weather forecasts and warnings.
- Other offices across Canada, which provide specialized client services, conduct research and maintain the extensive monitoring network.
- The Canadian Ice Service, located in Ottawa, that conducts ice surveillance and forecasting for the Arctic, the Eastern Canadian seaboard, the St. Lawrence River and the Great Lakes and maintains the national archive of sea ice, lake ice and iceberg information.
- The Canadian Meteorological Centre (CMC) in Montreal, that is the hub of national telecommunications, weather-modelling and emergency-response services. The CMC's computers handle about three trillion bytes of data per day. The CMC has one of the fastest scientific supercomputers in the world, which supports forecast production; weather research; and, climate, air quality and emergency response modelling activities.
- The MSC's archives, which store more than 100 years of climate data, representing seven billion observations. The data are used by researchers, the media and clients such as insurance and law firms and weather-sensitive industries such as construction, transportation, energy, agriculture and forestry.
- The Canadian Hurricane Centre (CHC) in Dartmouth, Nova Scotia, that is part of the Atlantic Storm Prediction Centre. The CHC gathers information on tropical and post-tropical cyclones, predicts the evolution of these storms and assesses and forecasts their potential impacts on Canadian territory. The Centre's area of forecast responsibility covers all Canadian territory, including Ontario, Quebec, the Atlantic provinces and all Canadian waters out to the 200 nautical mile limit.
- The Water Survey of Canada and its partners, which compute river flow and record the levels of lakes and rivers at more than 3 100 locations in Canada. Historical records from 7 700 sites estimate streamflow at ungauged locations. Our hydrometric network is being modernized to, among other things, better assist the provinces in flood prediction and prevention and provide a more comprehensive and accurate inventory of Canada's fresh water resources.

THIS YEAR IN WEATHER AS SEEN BY CANADA'S "WEATHER GURU"

David Phillips is Senior Climatologist for the MSC. His work involves activities that relate to the study, promotion and understanding of the Canadian climate. He is acknowledged as Canada's foremost weather expert, having been called a "genuine Canadian legend" and "our unofficial weather guru". He has appeared on The Weather Network and for nine years, wrote a column on weather for *Canadian Geographic*. In addition, he has written six books, including two best-sellers: *The Day Niagara Falls Ran Dry* and *Blame it on the Weather*. Each year, he compiles the Canadian Weather Trivia Calendar, the best-selling calendar in Canada. David estimates he conducts 500 media interviews per year and is invited to make 50 speeches annually.

David's secret when talking about the weather is to entertain first, inform second. He excels at communicating about science and clearly loves his job. In public service, he presides at swearing-in ceremonies for new Canadians where he explains the Canadian passion, if not obsession, for weather.

CREDIT: MSC

David Phillips

In recognition of his invaluable work for the MSC, David has received several prestigious awards, including, in 2001, the Order of Canada, our nation's highest honour, for promoting awareness and understanding of Canada's weather and climate. In 2004, David was awarded an honorary Doctor of Environmental Studies from the University of Waterloo. In 1999, he was named a fellow of the Canadian Meteorological and Oceanographic Society for outstanding service in communicating and interpreting weather and climate information to Canadians through the electronic and print media. In 1993, he received the Patterson Distinguished Service Medal from the MSC for distinguished service to meteorology.

Each year, David compiles a list of the top weather stories in Canada. These stories are determined by the degree to which Canadians were impacted, the area affected, the economic cost and its longevity as a news story. For 2003, the top ten weather stories are:

1. BC's year of disastrous weather – fires, floods and freezes
2. Hurricane Juan
3. Long, cold winter grips Eastern Canada
4. Canada ablaze from Ontario to the Okanagan
5. Endless drought in the Prairies
6. Atlantic Canada's most expensive rainstorm
7. New Brunswick's ice storm of a century
8. A record year of deadly avalanches
9. Alberta spring whitewashers
10. Ice age again in Badger, Newfoundland

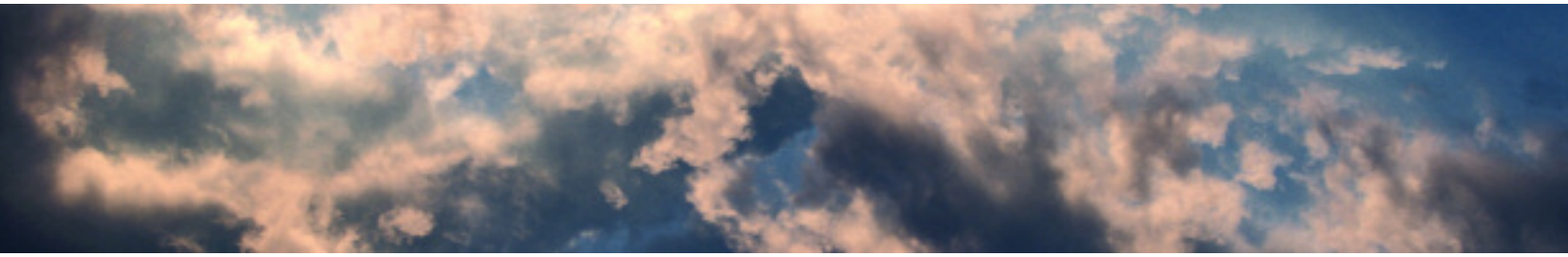
David concluded that the top weather story was the various disasters that struck British Columbia, including wind storms, avalanches, fires, floods and record rains. The province experienced its most expensive natural disaster and longest state of emergency when fires charred 2 650 square kilometres of land, 11 times the annual average area burned. Record autumn rainfalls led to major floods and mudslides, followed by record low temperatures for the month of November. David determined that the second top story was Hurricane Juan that struck headlong into Halifax in September. Juan was only the fourth category 2 hurricane to hit Nova Scotia since the 1800s. The storm changed the look of Halifax when it toppled millions of trees, some of them century-old. The weather events that occurred were expensive, with insured property losses and other disaster costs from the wildfires in BC and Hurricane Juan in the Maritimes alone totalling nearly $1 billion.

In 2003-2004, David analyzed new climate "normals" for Canada's 100 largest cities. From approximately a dozen basic elements, he created 72 weather categories by season or by year (for example, the sunniest winter city or the foggiest city year-round).

Some of the results are as follows:

- the city with the most typical Canadian weather is Montreal QC
- the cities with the toughest weather are St. John's NL and Gander NL
- the cities with the most comfortable weather are Victoria BC and Nanaimo BC
- the city with the coldest winter and coldest spring is Yellowknife NT
- the city with the warmest fall is Windsor ON
- the driest city is Whitehorse YT
- the city with the most thunderstorm days is Windsor ON
- the sunniest year-round city is Medicine Hat AB
- the city with the clearest skies year-round is Estevan SK
- the most humid summer city is Windsor ON

ref: http://www.msc.ec.gc.ca/media/top10/2003_e.html
ref: http://www.on.ec.gc.ca/weather/winners/intro-e.html



II. THE MSC MODERNIZATION

In March 2003, the Government of Canada announced increased funding to revitalize and transform the MSC. As a result of this funding – approximately $75 million over five years and $5 million per year thereafter – the MSC will be able to continually upgrade its infrastructure, advance its science and improve its services. This modernization process is directed toward one goal: ensuring the MSC provides the best and most useful weather information and services possible to safeguard the health and safety, security, prosperity and quality of life of Canadians.

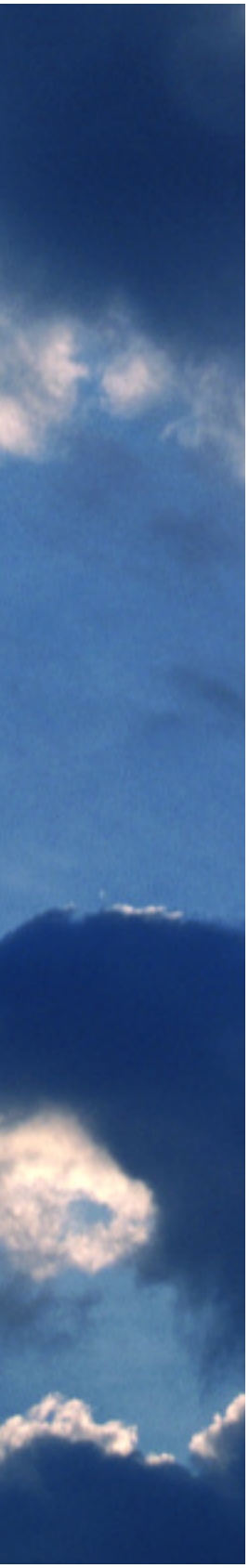
Key elements of transition are:

- consolidate and modernize the MSC's forecast operations into five Storm Prediction Centres (SPCs)
- improve implementation of new science and technology in operations
- create National Service Offices (NSOs) and increase outreach capacity
- introduce product and service enhancements and innovation
- invigorate the MSC's monitoring capacity
- restore and develop the MSC's key skill sets

2003-2004 was a pivotal year for the MSC as the modernization commenced in earnest.

RESTRUCTURING OF THE MSC

The transfer of forecast operations to the five new SPCs has begun, including the complete transfer of aviation services in Eastern Canada to the new centre in Montreal. Consolidation of aviation services in Western Canada was well advanced and will be completed early in 2004-2005. Consolidation will optimize efficiency of operations and create a critical mass of professionals in each centre. This consolidation will provide employees with the necessary time for ongoing training and professional development to ensure they have the proper skill-sets to deal with emerging science and rapidly advancing technology.



Each SPC will have a collocated National Lab, working on a particular meteorological theme. The goal is to bring the research function into closer contact with operations so that new scientific and technological techniques and tools can be integrated into operations faster, resulting in improved products and services to Canadians.

Several workshops were held to discuss the structure, roles and responsibilities of the new NSOs that are being created in Gander, Newfoundland (marine services); Rimouski, Quebec (media services); and Kelowna, British Columbia (road weather and weather-sensitive sector services) as well as the new National Service Unit in Regina, Saskatchewan (supporting the needs of the agricultural community). The result of the workshops was an Operating Charter for each office. As the role of the new offices took shape, the MSC identified the level and type of personnel required at each location. The MSC is on track to open these offices in 2004-2005.

As a result of this restructuring, 179 MSC employees were asked to re-locate and/or to take on new responsibilities. In 2003-2004, many of these cases were resolved. It is a credit to the MSC staff that the quality products and services so valuable to Canadians continued uninterrupted through the many extraordinary events of 2003.

SERVICE IMPROVEMENTS AND INNOVATION

A national survey conducted for the MSC in 2002 revealed that Canadians want safer winter roads. In 2003-2004, the MSC worked closely with provincial and territorial governments and Transport Canada to develop agreements to quality assure, archive and share data from road weather observation networks. The government included mention of the MSC's involvement in winter road maintenance in its ministerial announcement in March 2003. Data from the network, combined with forecasts of road temperature and conditions, will allow road maintainers to proactively treat the pavement in such a way as to prevent icing for improved safety while reducing the amount of salt used.

The ability of the MSC to produce high-quality products and services is strongly dependent on the quality and quantity of the data it acquires. To achieve the goal of invigorating the MSC's monitoring capacity, work has begun on retrofitting the observational networks. In 2003-2004, 21 climate stations and 14 surface weather stations were upgraded. These upgrades are a first step in applying a life-cycle management approach to these networks to ensure their integrity and usefulness well into the future.

Recruitment of technical and professional personnel was continued last year with the hiring of 21 meteorologists. Because our people are an essential component of the MSC and will be important to the success of the modernization process, the MSC will survey its staff annually throughout the modernization period. The first survey was issued to employees in December/January; the results are being used to formulate communication and engagement strategies for our staff.

III. OUR PARTNERS

THE MSC ADVISORY BOARD

A key to our partnerships is the work of the MSC Advisory Board, consisting of senior executives from various stakeholder and client groups. The Board provides guidance on our direction, major initiatives and partnerships with the private sector.

For example, in April 2003 several Advisory Board members met with MSC Senior Management for a special discussion on future monitoring strategies. One of the key future data requirements is increased spatial and temporal density of observations. The MSC is acting on the advice to increase partnerships to achieve this goal (for example, working cooperatively with municipalities and provinces on the road weather network and air quality monitoring).

Front row (seated): Kate Fawkes (Canadian Coast Guard), Samuel Scully (Dalhousie University), Pierre Morrissette (Pelmorex), John Mills (Environment Canada), Marc Denis Everell (Environment Canada)

Second row (standing): Carr McLeod (Environment Canada), Paul Kovacs (Institute for Catastrophic Loss Reduction), Phil Duffield (Ontario Ministry of Public Safety and Security), David Grimes (Environment Canada), John ApSimon (Carleton University), Ashkon Hashemi (Canadian Federation of Students), Gord Owen (Environment Canada)

Absent: Richard Cavanagh (Canadian Association of Broadcasters), Kathleen Fox (NAV CANADA), Robert Friesen (Canadian Federation of Agriculture), Michel J.C.M. Gauthier (Department of National Defence), Allan Jeffrey (Canadian Interagency Forest Fire Centre), Azzah Jenna (Federation of Canadian Municipalities)

MSC INTERNATIONAL R&D ADVISORY PANEL MEETING

The Atmospheric and Climate Science Directorate (ACSD) has convened an International Research & Development Advisory Panel composed of experts whose collective expertise covers the scientific mandate of ACSD. The panel is expected to meet approximately every two years and advise the ACSD Director General on: matters relating to the performance of ACSD, including accomplishments, capacity, funding, and interactions with partners; desirable directions for future ACSD research activities; and the suitability of the ACSD response to recommendations from the external peer review.

The panel's first meeting was held in October 2003. The panel allows for an ongoing review of the MSC research program which was initiated with the full peer review held in 2001. The membership of the panel is: Dr. Joe Friday (Chair), Sasaki Applied Met Research Institute (US); Dr. Jerry Mahlman, University Corporation for Atmospheric Research/National Center for Atmospheric Research Advanced Study Program (US); Dr. Peter Manins, CSIRO Atmospheric Research (Australia); Dr. Philippe Coutier, Météo-France; Dr. Kim Partington, Vexcel UK Limited.

DOMESTIC PARTNERSHIPS

We work with partners in nearly everything we do. Our partnerships are designed to meet specific client and stakeholder needs and support outreach efforts that communicate weather, water, climate and other information to Canadians. The mass media are one of our most important partners in getting our warnings and forecasts to Canadians. Our research and development is done in collaboration with universities and/or research institutes. Our water level monitoring activities rely heavily on partnerships with the provinces and territories.

Our three biggest partners are NAV CANADA, the Canadian Coast Guard and the Department of National Defence.

WEATHER SERVICES TO NAV CANADA

In partnership with NAV CANADA, the privatized operator of the Canadian air navigation system, the MSC provides many of the specialized meteorological products and data services that the aviation industry requires to operate safely and efficiently. Some of the products provided in whole or in part by MSC personnel include graphical area forecasts for the entire country, including an outlook to 24 hours of weather, icing and turbulence conditions; 12 to 24 hour site-specific forecasts of ceiling, visibility, wind and weather for approximately 170 airports; and specialized thunderstorm and turbulence forecast charts for air-traffic flow management that ensure an effective and efficient use of airspace.

Through the agreement for aviation weather products and services, the MSC and NAV CANADA collaborate in a way that has distinct benefits for each. For example, the MSC relies on the NAV CANADA-funded aviation observing network for programs such as understanding climate change, while NAV CANADA benefits greatly from the MSC-funded upper-air observing network that leads to accurate reports and predictions of flight level wind conditions.

OPERATIONAL SUPPORT TO THE DEPARTMENT OF NATIONAL DEFENCE

Dedicated offices provide meteorological services to the army, navy and air force components of the Department of National Defence. Forecast, consultation services and data services are provided from these MSC offices situated in military facilities around the country to support domestic exercises and international peace-keeping responsibilities. For example, the MSC's Weather Services Centre (WSC) at the Trenton Air Force Base issued real-time forecasts to support Canadian Forces aviation operations in southeast Asia. WSCs in Comox and Halifax provided detailed marine weather warning and forecast services to Canadian ships en-route to and from the Persian Gulf as part of Canada's contribution to the international efforts against terrorism.

CANADIAN COAST GUARD

Working closely with the Canadian Coast Guard, the Canadian Ice Service provides information on past, present and future sea ice, lake ice and iceberg conditions in Canadian waters. This information is provided to the public, other government departments and other levels of government to enhance the safety and efficiency of marine operations in ice-encumbered waters. The Canadian Ice Service provides information services and scientific and technical expertise to support the effective operation of the Canadian Coast Guard's icebreaking program.

The following examples are the results of other partnerships during 2003-2004.

INDUSTRIAL RESEARCH CHAIR IN EXTREME WEATHER

In January 2004, McGill University hosted a celebration for the Natural Sciences and Engineering Research Council Industrial Chair in Extreme Weather. This Chair is supported by Environment Canada, through the MSC, and by the Institute for Catastrophic Loss Reduction. The Chair is held by Professor Ronald Stewart, a former senior MSC scientist, and will enhance the teaching and study of the causes and consequences of extreme weather events. The MSC is investing $500 000 over the next five years in this initiative.

ENERGY SECTOR PARTNERSHIPS

The Wind Energy Simulation Tool (WEST), developed by the MSC, allows users to identify the most suitable location to install a wind turbine or wind farm. Since the development of the WEST, demands on the MSC by the wind energy sector have substantially increased. A wind energy Atlas has been developed for use by the industry, and specific studies have been carried out for Manitoba Hydro and the province of Quebec using WEST.

INTERNATIONAL PARTNERSHIPS

Canada, through the MSC, is a key player in international meteorological initiatives. Some of these activities are carried out under the auspices of the World Meteorological Organization (WMO). There are also many bilateral agreements with National Meteorological and Hydrological Services of individual countries – for example, the Chinese Meteorological Authority, the National Weather Service of the US, MétéoFrance – and other consortiums and working groups dedicated to the advancement of environmental prediction.

The ADM of the MSC is the permanent representative on the WMO Executive Council, and many MSC employees are key members of a number of WMO committees, including the Commission on Basic Systems, the Commission on Climatology, the Commission for Aeronautical Meteorology and the World Climate Research Programme. Some of our other major international initiatives are described below.

GLOBAL EOS-GEO

At a July 2003 Ministerial Earth Observation Summit in Washington, 33 countries including Canada and over 30 international organizations endorsed a Declaration for an expanded international effort to improve Earth observation capabilities by and for all nations. Canada is well placed to contribute to this effort, with recognized expertise in remote sensing, space technology, *in situ* monitoring and data processing and through its world class efforts in developing mathematical models of its atmosphere and oceans. Canadians will benefit from participation in this initiative through efficiencies within government programs, improved access to and quality of data and information from other nations and potential commercial opportunities for industry in the development and implementation of future systems.

The inter-governmental Group on Earth Observations (GEO), formed by the first Earth Observation Summit in July 2003, is responsible for developing a conceptual framework and a 10-year implementation plan for a comprehensive, coordinated and sustained global Earth Observation System of Systems. The ADM of the MSC is the GEO representative for Canada.

The first interdepartmental workshop for the Canadian GEO was held at the Canadian Space Agency's headquarters in St. Hubert, Quebec, in January 2004. More than 60 government experts in earth observation (EO) and senior representatives from the participating bodies attended the workshop, entitled "Strengthening Earth Observing Capacity in Canada: Delivering on the Earth Observation Summit". The results of the workshop were to: build awareness of international efforts; identify synergies in national and international efforts; agree on Canada's role in GEO; identify benefits to Canada and measures of success; provide an overview of Canadian EO activities; identify potential Canadian EO contributions and their rationale; identify Canadian EO priorities; and plan the path forward in engaging stakeholders.

CREDIT: MSC

Canadian EOS delegation (from left): Pierre Richard (Canadian Space Agency), Jean Boutet (Environment Canada), Susan Till (Natural Resources Canada), David Anderson, former Environment Minister, Marc Denis Everell (MSC), Wendy Watson Wright (Department of Fisheries and Oceans), Alan Tonks (Parliamentary Secretary to the Minister of the Environment), Virendra Jha (Canadian Space Agency)

AGREEMENT WITH NOAA FOR THE EXCHANGE AND USE OF ENVIRONMENTAL DATA

In 2002-2003, the MSC finalized a formal Agreement with the US National Oceanographic and Atmospheric Administration (NOAA) to enhance the exchange and use of environmental data. As part of this agreement, the MSC's Canadian Ice Service is working with the US Coast Guard to integrate sea ice, lake ice and iceberg information available to the North American marine community. The goal of this collaboration is to improve the quality of information available to users while reducing duplication of effort and cost. This initiative, developed on the Great Lakes over the last three years and expanded to the Arctic in 2004, will be expanded to iceberg information in 2005. At this time, common production standards have been adopted and shared production is in place. Joint training activities are also under way. In the future, it is envisioned that development activities will be integrated, leading to a completely integrated production infrastructure.

THORPEX

The MSC is actively involved in a WMO initiative, the THORPEX programme, to organize global weather research associated with high impact weather. As stated in the North American THORPEX regional plan, *"…North America experiences diverse and severe weather including flash floods, droughts, tropical storms, hurricanes, hail, tornadoes, damaging winds, snow storms, blizzards, freezing rain, heat waves, "fire weather" and episodes of stable, stagnant weather that can cause fog or reduce air quality. THORPEX will make progress by enhancing international collaboration between the research and operational forecast communities and with users of forecast products. Specifically, THORPEX is designed to accelerate improvements in the accuracy of 1 to 14-day high-impact weather forecasts for the benefit of society and the economy..."*

Dr. Michel Béland, Director General of the MSC's Atmospheric and Climate Services Directorate, serves as Chair of the CAS International Core Steering Committee for THORPEX and Dr. Pierre Gauthier, Chief Research Scientist with the MSC, serves as the co-chair of the North American Regional THORPEX Committee.

CREDIT: US COAST GUARD

The laker Edwin H. Gott near Duluth Harbour

IV. OUR PRODUCTS AND SERVICES

Weather services are among the most frequently used federal government services. Results of past surveys indicate that 92 percent of Canadians consult weather forecasts at least once per day. The MSC is at the source of all such forecasts, either in providing the official forecast through the media or directly to Canadians or in providing the data by which others produce their own forecasts. Annually, the MSC issues approximately:

- 14 000 severe weather warnings;
- 3 500 ice hazard warnings;
- 500 000 public weather forecasts;
- 200 000 marine weather forecasts; and,
- 400 000 aviation forecasts.

The mass media are our primary means of reaching Canadians and are vital to ensuring that Canadians receive weather information, particularly warnings, in a timely manner. Weather information can be accessed via the following Environment Canada dissemination systems:

- *Weatheradio:* weather information is continually broadcast over Weatheradio VHF frequencies.
- *Internet:* the MSC's "weatheroffice" website is becoming a major source of weather information and warnings for Canadians.
- *Telephone:* free recorded messages in most parts of the country provide basic public forecasts and a 1-900 user-pay phone service enables callers to speak directly to a meteorologist 24 hours a day.

In addition, the MSC produced other more specialized products in 2003-2004. For example, information on ultraviolet radiation (UV index) and wind chill is included in public forecasts depending on the season. Daily air quality forecasts are also produced in many parts of the country. This section highlights some of the MSC's successes from 2003-2004 in the provision of products and services.

FORECAST PRODUCTS

NEW PUBLIC AND WARNING FORECAST REGIONS FOR CANADA

Our staple product is the Public Forecast. It is issued twice daily, in the early morning and late afternoon; updates are provided in the late morning. The MSC modified Environment Canada's public weather forecast regions in Canada in 2003-2004 to better reflect existing geopolitical boundaries, climatology, transportation, recreation and population distributions. The number of public forecast regions increased from 388 to 418. Changes were made to the number of regions in Ontario (47 to 62), Newfoundland and Labrador (28 to 35) and Alberta (26 to 34).

UV PROGRAM RENEWAL

During the spring and summer seasons, the UV Index portion of the Public Forecast informs Canadians of the hazards of ultraviolet radiation. In spring 2004, the forecast methodology for the UV Index was improved: it now takes into account elevation, and, in part, reflection of UV radiation by snow on the ground, two factors not previously included. Additionally, the scheme to determine the UV Index based on observations from Brewer spectrophotometers has been improved. These changes will result, particularly in the spring, in a forecast UV Index that will be somewhat higher than in the past. As well, the criteria used to include the UV Index in public forecasts have been changed. The index is now included, rounded to the nearest whole number, whenever it is forecast to be three (the "moderate" category) or more, regardless of the season.

WIND CHILL PROGRAM IMPROVEMENTS

The MSC updated its wind chill program in 2003-2004 to provide Canadians with better information on the risk of frostbite under various wind and temperature conditions. Research results indicate that there is little or no chance of developing frostbite with a wind chill index warmer than minus 28 (calibrated on the Celsius scale) and that virtually everyone develops frostbite with a wind chill index value of minus 40 or lower. These results have been incorporated into the wind chill program; the program also includes updated information on the time (in minutes) that is needed for the development of frostbite. The MSC is now exploring ways to better integrate the frostbite guidelines into its wind chill program for winter 2004-2005.

JOINT CANADA – US CONVECTION FORECASTS

Because meteorology does not recognize national borders, Canadian and US meteorological services have collaborated since summer 2002 in the interest of serving the aviation community. From April until the end of October, the high season for thunderstorm activity, MSC and NWS meteorologists and aviation-company experts exchange data on a near-hourly basis to arrive at a consensus on convective activity over the next six hours. They create maps of all the thunderstorm systems in the Great Lakes/southern Quebec area larger than 30 by 60 miles with tops exceeding 25 000 feet. The maps, issued 12 times per day on the Internet, indicate how the storms are expected to move over the next two, four and six hours and have proved invaluable in providing improved routing of air traffic around these dangerous systems. The result has been safer and more efficient air traffic for civil aviation and the travelling public.

MSC SUPERCOMPUTER

The MSC operates one of the most powerful computers in Canada. It runs simulations of the atmosphere and produces environmental forecasts. On December 25, 2003, nearly four years after the project began, the Supercomputer Replacement Project officially ended with the acceptance of the new IBM system. The new system is 2.5 times more powerful than the previous one. Nearly 50 MSC employees were involved in implementation of the system, which included determining user requirements for the next decade and preparing technical specifications. Implementation culminated with a year-long system installation, system performance verification and conversion process.

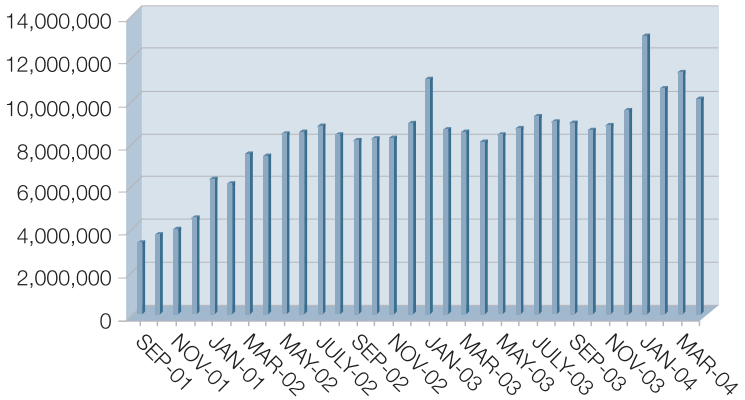
This new technology means that scientific improvements that have been developed can be transferred to operations at an accelerated pace over the next year, resulting in more accurate forecasts in the one-to-five day range, as well as allowing new techniques to extend forecasts to ten days. Not only will our forecasting capacity and accuracy improve, our research will be greatly enhanced as well. The new computer will allow the Canadian Centre for Climate Modelling and Analysis (CCCma) in Victoria to push the boundaries of climate change research. The CCCma is one of the biggest users of Canada's supercomputing facility.

INTERNET PRODUCTS AND SERVICES

WEATHEROFFICE USE INCREASES

The MSC's weather website continues to grow in popularity with an average of 325 000 visits per day during 2003-2004. The number of visits increases dramatically on significant weather days, such as Hurricane Isabel. Investments in 2003-2004 in "weatheroffice" have resulted in a significant increase in the website's dependability and capacity. The operation and maintenance of the site are highly complex due to the automated processes that are required to update the information to parallel the changing weather of Canada.

WWW.WEATHEROFFICE.EC.GC.CA
WEB SITE SERVICE ACTIVITY



VISITS TO WEB SITE PER MONTH

SUPPLYING HISTORICAL HYDROMETRIC DATA ON-LINE

The national hydrometric program is an example of the cooperative management of Canada's water resources by the federal and provincial governments. It provides for the collection, interpretation, and dissemination of surface water quantity data and information.

The program is carried out under formal agreements between Environment Canada and each of the provinces and the Department of Indian and Northern Affairs (representing the territories). The agreements provide for the collection of surface water quantity and sediment data on a national basis, with costs shared according to specific interests and needs.

Under the agreements, the federal government publishes the data that have been collected according to national standards. The data are stored in the national HYDAT database, also known as the National Water Data Archive. The archive contains daily, monthly and instantaneous data for streamflow, water level and sediment data for over 2 500 active and 5 500 discontinued hydrometric monitoring stations across Canada. Effective in 2003-2004, all historical streamflow and water level data can be accessed on-line along with period-of-record statistics for most stations.

ref: http://www.msc.ec.gc.ca/wsc/hydrat/H2O/index_e.cfm

CLIMATE SCIENCE AND DATA IN THE CYBERSPACE

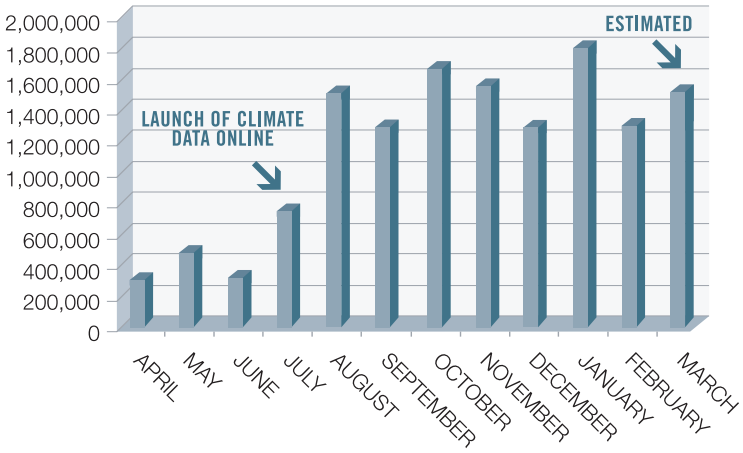
A new website was launched in July 2003 by Minister Anderson that provides basic interactive public access to historical weather and climate data from the MSC's national climatological database. The number of page views for the MSC's climate site increased six-fold after the launch of the website. In total, in 2003-2004, the public was provided with over 13 million separate pages of information about the Canadian climate. Thus far, January 2004 was the busiest month for the website.

ref: http://www.climate.weatheroffice.ec.gc.ca

The MSC delivers a broad spectrum of other up-to-date climate products and services to the Canadian public and users in the climate science community. Products that are delivered to Canadians via the Internet or other electronic means include:

- *The Climate Trends and Variation Bulletin*, published regularly on the Internet at **http://www.msc-smc.ec.gc.ca/ccrm/bulletin/**. *The Bulletin* summarizes recent seasonal and annual climate information for Canada in an easily understandable form with text, maps, and graphs in the context of historical measurements.
- Authoritative information for Canadians on the El-Nino/La-Nina phenomenon and its influence on our climate. This Canadian perspective can be found on the Internet at **http://www.msc-smc.ec.gc.ca/education/elnino/**.

PUBLIC TRAFFIC ON THE MSC CLIMATE INTERNET SITE 2003/04



- Projections of the potential effects of greenhouse gas warming on the climates of Canada and the world. These projections, produced with Canada's state-of-the-art climate model, are available from **http://www.cccma.ec.gc.ca** and are used extensively across Canada and abroad by students and researchers.

SAFETY FROM AND RESPONSE TO ENVIRONMENTAL AND SECURITY HAZARDS

One of the MSC's key goals is to safeguard Canadians against imminent high impact weather and environmental hazards, including reducing the impact of weather and related hazards on health, safety and the economy. To realize this goal, the MSC works with security agencies to provide weather information in support of human-induced hazards such as nuclear accidents or terrorist attacks. The MSC has national and international responsibilities that are directly related to counter-terrorism. The CMC provides real-time 24/7 atmospheric transport and dispersion modelling of radioactive tracers and other expertise and technical support to the Federal Nuclear Emergency Plan and the National Counter Terrorism Plan.

The following are examples of specific work undertaken by the MSC during 2003-2004 to safeguard the health and safety of Canadians.

CREDIT: MSC

Houses ablaze in southern BC.

DEVASTATING FIRES IN BC

Devastating forest fires burned in several areas of southern and southeast BC in August and September, 2003. MSC – Pacific and Yukon Region staff at the Mountain Weather Centre in Kelowna worked long hours to provide meteorological support for firefighter and public safety use. At the peak of the crisis, MSC staff in Vancouver and Edmonton assisted by taking on Kelowna's forecasting workload for northern BC and the Yukon, while the Victoria service unit dealt with information requests from the media. Extra soundings from the Kelowna Upper Air Station were provided to assist the fire weather forecasters. Shortly after the Kelowna fire was brought under control, another major burn was triggered near the city of Cranbrook in southeastern BC. The ER mobile upper air station was deployed by MSC staff to provide upper air data using a mobile system.

The provision of accurate wind and temperature forecasts and observations by the MSC enabled firefighting activities, including evacuation orders, to be optimized. All MSC forecasters who were involved were presented with regional awards in September 2003 in recognition of their efforts.

SCIENCE FOR MUNICIPAL DECISION-MAKERS: ATMOSPHERIC HAZARDS IN ONTARIO

The MSC, in partnership with Emergency Management Ontario, has delivered Atmospheric Hazard scientific information to all municipalities in Ontario, under the new *Emergency Management Act*. The atmospheric hazards website includes maps and co-recognition software (cumulative hazards) to assess current atmospheric hazards as part of the detailed risk assessment legally required by each municipality by December 2004. Gaps have been identified that will enable future development of new maps and knowledge to ensure that comprehensive atmospheric hazards science is available for municipal decision-makers.

ref: http://www.hazards.ca

CREDIT: MSC

ER mobile upper air station in Cranbrook

MSC HOSTS INTERNATIONAL HURRICANE WORKSHOP

In November 2003, the MSC hosted the second International Workshop on Extra-tropical Transition (IWET) in collaboration with the WMO and the Search and Rescue Secretariat. The purpose of the workshop, attended by hurricane experts from many mid-latitude countries, was to improve the understanding and prediction of transitioning hurricanes, a problem of particular importance to the east coast of Canada. Advances and challenges in researching and forecasting these unique storms were shared through presentations, forums and hands-on activities. MSC researchers presented their latest findings on northern hurricanes at the workshop.

Canada's research flights into hurricanes Isabel and Juan were a hot topic at the conference. Data collected during the flights showed that, although hurricanes tend to be symmetrical, the winds during hurricane Juan were much higher on one side due to the speed of the storm's movement. Other MSC research confirmed that offshore water temperatures during Juan were approximately three degrees Celsius above normal. Simulations done with a computer model show that these temperatures caused the storm's wind speed to increase by approximately 25 kilometres per hour.

The conference concluded with a discussion on future research and collaboration, with plans to establish an international website on extra-tropical transition. The MSC's hurricane experts will carry out more research flights during the 2004 hurricane season.

PROJECT OPPORTUNITY

Highway 401, from Windsor, Ontario to the Quebec border, is a major transportation route. Following a fog-related accident near Windsor in fall 1999, a coroner's inquest recommended that Environment Canada investigate ways to work more closely with the Ontario Provincial Police (OPP) in the provision of weather information.

Project Opportunity establishes a symbiotic relationship between the OPP officers who patrol the highway and the MSC meteorologists who forecast the weather. Established services include a password-protected web page displaying current weather observations and weather warnings, forecasts, radar and satellite imagery and automated delivery of specific weather warnings affecting the OPP dispatch area. Additionally, there is a web-based reporting tool that allows a "pop up window" to notify the MSC of critical weather events reported by the OPP. This information can be incorporated into MSC severe weather warnings and statements. MSC staff and staff in the OPP Communications Centres are encouraged to contact each other when additional information is required.

MONITORING THE ENVIRONMENT

Data are critical to the environmental prediction process. In Canada, information on weather, air quality, ice, snow and water are gathered through an array of observation networks, some based on the ground or in water and others operating from the upper atmosphere and space. The following section describes some highlights of the MSC monitoring activities in 2003-2004.

CREDIT: MSC – ATLANTIC REGION

Jubilee Road, Halifax, post-Hurricane Juan

COMPLETION OF THE NATIONAL RADAR PROJECT

The National Radar Project (NRP) was completed in March 2004 with the commissioning of the Northeast Ontario Radar near Departure Lake. The NRP finished on time and under budget.

From 1998 to 2003, the NRP installed 11 new Doppler weather radars and retrofitted 19 existing weather radars with Doppler capacity. The new national radar network has 31 Doppler radars providing radar coverage to over 98 percent of Canadians and over 28 percent of Canada's land mass. The pre-NRP network provided Doppler radar coverage to 49 percent of Canadians and only 1.1 percent of Canada's land mass.

MEASUREMENT OF MERCURY IN THE LOW ARCTIC

In 1999, experiments conducted by the MSC in Northern Quebec showed that atmospheric mercury depletion in the spring contributes to the contamination of snow and meltwater. Measurements taken in 2003-2004 also show that atmospheric mercury deposited on snow in the spring may contribute to increased mercury concentration in Arctic vegetation, including the mosses and lichens that caribou consume.

AVOS SYSTEM INSTALLATIONS

The Automated Volunteer Observing Ship (AVOS) system is an automatic weather observing station installed onboard selected ships. It automatically transmits regular observations including pressure, temperature, humidity, wind, sea temperature, as well as the ship's position, speed and direction of motion. Values for additional parameters such as visibility and sky and ice conditions can be added manually.

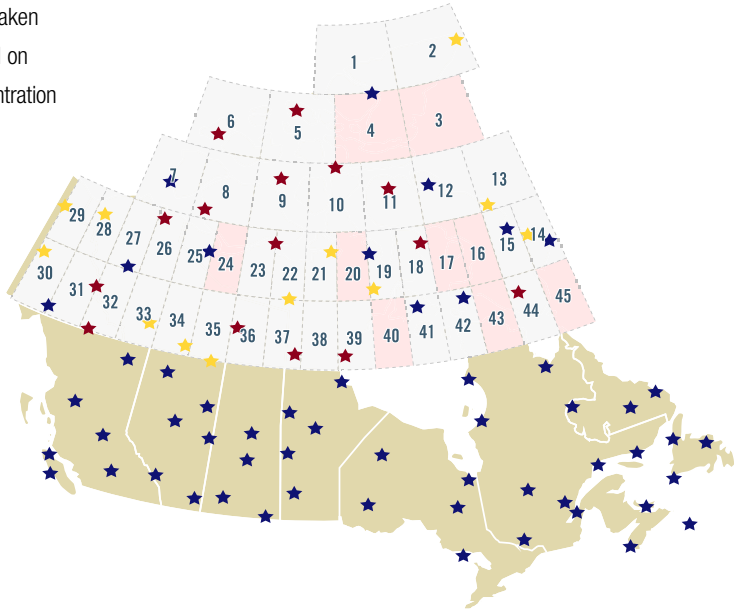
The MSC has selected 75 ships for AVOS installations based on their travel routes and sailing frequency. The goal of this initiative is to maximize the number and quality of the observations in data-sparse areas, primarily Canada's North and Canadian coastal waters, which will lead to improved marine forecasts.

In the first year of a three-year funding initiative from the New Search and Rescue Initiative Fund, six AVOS systems were installed, for a total of 20 AVOS-equipped ships. The funding will provide for 18 systems over three years, with the MSC covering all installation costs.

CREDIT: CANADIAN COAST GUARD

AVOS touch sensitive data entry screen.

GCOS SURFACE NETWORK (GSN) INCLUDING: NEW STATIONS IN 2002/2003; 2003/2004



ADDITIONAL GSN STATIONS IN CANADA'S NORTH

Action Plan 2000 on Climate Change financed the upgrade and/or installation of 11 new Global Climate Observing System (GCOS) Surface Network (GSN) stations in 2003-2004. There are now 26 new or upgraded GSN stations north of 60 degrees, created under this funding. To achieve adequate global coverage, the GCOS goal is to have a monitoring station in each 570 x 570 km grid for the world. Canada's regional coverage does not meet this standard as there are large geographical gaps in the north that hamper the MSC's ability to understand environmental change and its implications. The MSC plans to install 21 stations in 2004-2005. The MSC is upgrading existing GSN stations, which primarily provide temperature and total precipitation data sets, to include measurement of wind speed and direction, humidity, rate-of-rainfall, snow cover and radiation. These enhanced data sets are needed to effectively document and understand climatic processes.

IMPROVED SATELLITE DATA FOR ICE FORECASTING

In 2003, the MSC began receiving and analyzing daily Envisat synthetic aperture radar (SAR) satellite images. The MSC monitors ice and iceberg conditions in Canadian coastal waters to support year-round marine activities. Ice conditions are monitored primarily through the analysis of daily satellite images from Canada's RADARSAT-1 satellite, now nearing the end of its mission life. The RADARSAT-2 mission is scheduled to launch and begin operations in 2005. By tapping into the Envisat data stream in the interim, the

CREDIT: EUROPEAN SPACE AGENCY

Envisat radar

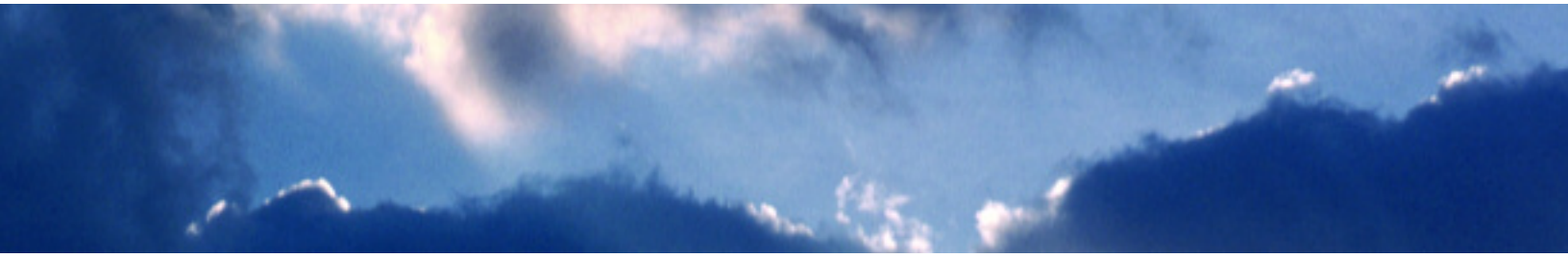
MSC has ensured a continual flow of SAR satellite imagery for ice monitoring in the event of a gap between Canada's RADARSAT-1 and RADARSAT-2 missions. Currently, the Envisat images are being ordered to complement the RADARSAT-1 imagery, thus providing timelier and wider satellite coverage for ice operations.

ROAD WEATHER INFORMATION SYSTEM FOR CANADA

Minister Anderson's March 2003 modernization announcement specifically referenced funding for the MSC to assist the provinces with the proposed national Road Weather Information Service (RWIS) for Canada. In August 2003, Transport Canada (TC) announced the beginning of negotiations with the provinces and territories leading to contribution agreements to launch the road weather monitoring network. TC will pay up to 50 per cent of the eligible costs relating to the acquisition and installation of road and weather condition system components, subject to the successful conclusion of the contribution agreements. The MSC will provide core data services such as assuring data quality and building a national integrated RWIS database for the transportation sector.

MSC PROVIDES SUPPORT TO THE HERITAGE CLASSIC

The organizers of the Heritage Classic hockey game and the Edmonton Oilers hockey team established a contract with MSC – Prairie and Northern Region for weather support for the Heritage Classic hockey game in November 2003, held in Edmonton. The MSC supplied consultation support leading up to and including game day and answered questions from media representatives. An on-site MSC representative was available to verify weather conditions.



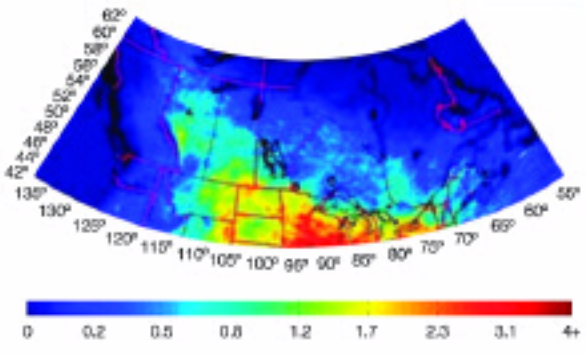
V. OUR SCIENCE

The MSC conducts research to ensure that Environment Canada has a solid scientific foundation on which to develop policies and strategies that safeguard the environment and protect human health. During 2003-2004, our staff in the regions and headquarters conducted research in a wide variety of areas related to air quality, climate change, hurricanes, ice, water, weather and adaptation to atmospheric change, variability and extremes.

WEATHER RESEARCH AND DEVELOPMENT

STUDY PINPOINTS LIGHTNING HOT SPOTS

An MSC study conducted in 2003-2004 identifies areas of Canada where lightning occurs most often. In summer, when most storms occur, these “hot spots” include parts of southern Ontario, southern Saskatchewan and Manitoba and the foothills of Alberta. In winter, the most lightning occurs over the Atlantic Ocean just south of Sable Island, where cold Arctic air collides with warmer air from the Gulf Stream. Lightning is less common in northern regions of the country and in most of British Columbia.



CREDIT: MSC – ONTARIO REGION

Average annual number of lightning flashes per square kilometre, based on 1998 to 2002 data.

The study's findings are based on observations collected by the Canadian Lightning Detection Network over the past five years. The network has 83 sensors located across Canada and forms the northern half of a continental network that is the largest of its kind in the world.

Lightning flashes occur in Canada about 2.7 million times per year. Lightning strikes kill approximately six Canadians each year, seriously injure about 70 people and ignite some 4 000 forest fires.

Information on the location, strength and timing of lightning is important to operations that are vulnerable to direct hits or to fluctuations in electric power. For example, the aviation industry relies on it to protect aircraft and ground crews, while forestry and parks services use it to determine where lightning-induced fires are most likely to occur.

ref: www.msc.ec.gc.ca/education/lightning/index_e.html

BC OFFSHORE OIL AND GAS

For the past two years, MSC – Pacific and Yukon Region has led the meteorological input into the BC government-initiated review of the West Coast Moratorium on Oil and Gas Drilling and Exploration. During this period, MSC staff analyzed the meteorological knowledge gaps related to conducting safe and environmentally responsible hydrocarbon activities on the BC coast. Although the full consideration of the moratorium has not concluded, it reached a critical stage in October 2003, culminating in the Royal Society of Canada hearings commissioned by the BC government. An MSC meteorologist made presentations to the Royal Society of Canada Expert Panel on Science Issues Related to the Moratorium at which meteorological knowledge gaps were discussed.

CREDIT: MSC – ACSD

MSC's Cruiser vehicle

WATER SCIENCE

THREATS TO WATER AVAILABILITY IN CANADA REPORT

In September 2002, Environment Canada's National Water Research Institute (NWRI) and the MSC organized a workshop to discuss the threats to the availability of freshwater in Canada. In March 2004, *Threats to Water Availability in Canada* was released. Production of this peer-reviewed document was directed by leading scientists from the NWRI and the MSC. Written by approximately 70 experts from academe, industry and various levels of government, the report examines "priority" threats to water including urban development, industrial and manufacturing demands, agriculture, and, above all, climate change. It states that climate change, or variability in climate, could have significant effects on Canada's water supplies, causing an increase in the frequency of droughts and floods, shrinkage of glaciers and a reduction in permafrost. The report also examines the demands placed on Canada's water by different sectors and identifies areas where more research is needed; for example, to increase the ability to predict changes to the hydrologic cycle and how to offset them.

ref: http://www.nwri.ca/threats2full/intro-e.html

AIR QUALITY SCIENCE

INITIATIVES SUPPORTING THE BORDER AIR QUALITY STRATEGY

In 2003, Canada and the US agreed to improve transborder air quality by implementing the Border Air Quality Strategy (BAQS). A series of projects designed to better understand the movement of air pollution and its effects on transborder air quality is under way.

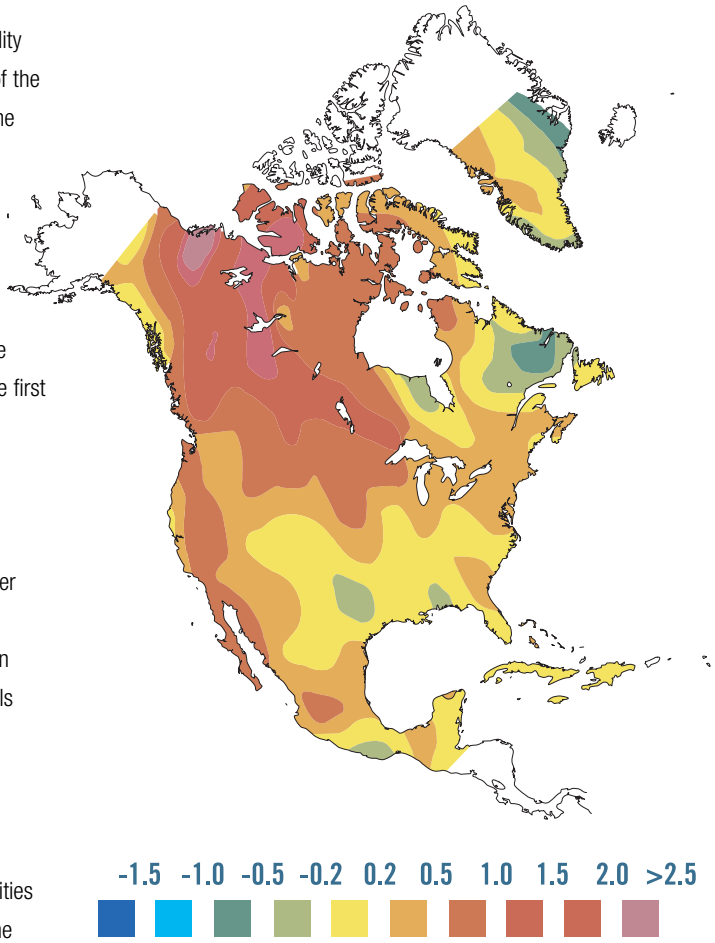
In February 2004, the MSC participated in the Windsor Air Quality Symposium that focused on achieving a better understanding of the current state of air quality in the Windsor Essex County area. The MSC is working on innovative technologies to measure air pollution at the Canada-US border and other areas by introducing a vehicle that has the capacity to take real-time measurements while in motion. This technology can be operated in conjunction with lidar technologies to better characterize air quality using 3D mechanisms that provide more detail about atmospheric particle composition. The project is the first of its kind and will provide more accurate data to pinpoint the source and type of air pollutants and to determine the level of human exposure.

The MSC is also involved in work being done in the Lower Fraser Valley of British Columbia as part of the Georgia Basin/Puget Sound International Airshed pilot project. This project focuses on reducing particulate matter and toxic emissions from diesel fuels and marine vessels.

MSC PARTICIPATES IN SCISAT SATELLITE MISSION

In August 2003, Canada launched its SCISAT satellite via the release of the U.S. Pegasus XL rocket from NASA's launch facilities in California. The satellite will study changes in the earth's ozone layer with emphasis on the Arctic. This research is important because severe thinning of the Arctic ozone layer could become more apparent in the future due to the emission of industrial chemicals. Additionally, preliminary study findings suggest that climate change may be altering the Arctic atmosphere, making it more susceptible to ozone loss.

The SCISAT satellite was developed by the Canadian Space Agency and carries two ozone-measuring instruments including MAESTRO (Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation), developed by Environment Canada and MSC scientists. The MSC is a world leader in ozone research, and provides the global calibration source for Brewer ozone measurements at approximately 100 stations around the world.



Observed 1950-2000 trend in surface air temperature
(Units: ºC per 50-years)

CLIMATE CHANGE SCIENCE

The MSC has an internationally respected global climate modelling group, the Canadian Centre for Climate Modeling and Analysis (CCCma), located at the University of Victoria. The CCCma is a key player in the assessment reports of the Intergovernmental Panel on Climate Change (IPCC), and disseminates extensive climate change

information to university researchers, private industry and the public from its popular web site, **http://www.cccma.ec.gc.ca**. The Centre interacts extensively with the university and with the Department of Fisheries and Oceans' Institute for Ocean Sciences.

STUDIES SHOW HUMAN FOOTPRINT ON CLIMATE

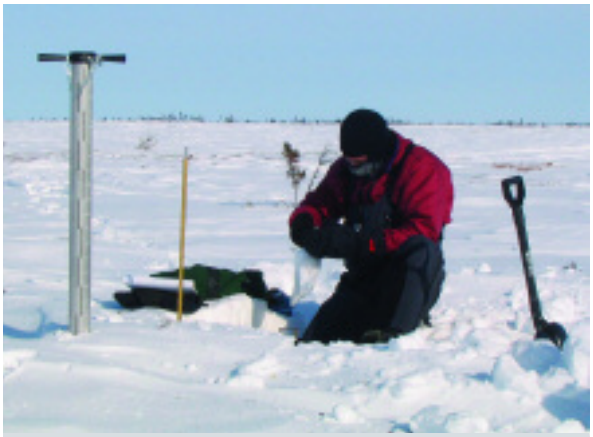
Much of Canada has experienced increasing temperatures during the past half century. Globally, human activity has been identified as the cause of these temperature increases. However, attributing the cause of such changes over smaller areas – individual continents or countries – has until recently, been extremely difficult. The signal of climate change is small in relation to natural climate variations on these scales. MSC scientists have shown for the first time that temperature increases in North America during the past 50 years are linked to increased emissions of greenhouse gases. They have shown that this link can also be made for temperature increases in the Arctic and in Eurasia.

Greenhouse gas emissions may also affect other aspects of the climate, for example, atmospheric circulation. A study conducted by an MSC scientist, in collaboration with researchers at the University of Victoria and the UK Met Office, demonstrates that a human footprint is now detectable in sea-level pressure data collected globally over the past 50 years. This is the first study to formally detect a human effect on the global climate that does not use temperature data.

These detection results demonstrate convincingly that climate models are able to simulate observed changes in the climate system caused by increased emissions of greenhouse gases. This success in turn increases our confidence in projections of future climate change and their use as a sound scientific basis for the development of adaptation and mitigation strategies. These results will contribute to the IPCC 4th Assessment Report, to be published in 2007.

CLIMATE CHANGE INDICATORS

Long-term climate data from the MSC are showcased in a federal-provincial-territorial report by the Canadian Council of Ministers of the Environment. The report, *Climate, Nature, People: Indicators of Canada's Changing Climate*, examines changes in 17 climate and climate-related indicators in the 20th century. An MSC scientist was the federal co-chair for the project, which took over three years to complete. Several other MSC employees were members of the Climate Change Indicators Task Group that directed and reviewed the report.



CREDIT: A. SILIS

MSC scientist

The report suggests that the climate in many regions of Canada is changing, but that the rate, extent, and impact of change varies from one area to another. Nearly all of Canada has become warmer and wetter over the past century. Sea surface temperatures rose substantially on the west coast, but changed little on the east coast. This warming trend has had a variety of impacts, including a shorter ice season, rising sea levels, shrinking glaciers, a longer growing season and reduced heating needs in most parts of the country.

ref: http://www.ccme.ca/initiatives/climate.html?category_id=33

CARBON SINKS IN CANADA

The MSC, with support from the Action Plan 2000 on Climate Change and the Program of Energy Research and Development, is a national leader in measuring and modelling the carbon, water and energy cycles of the Canadian boreal forest. Since 1997, it has led the Boreal Ecosystem Research and Monitoring Sites (BERMS) program in collaboration with the Canadian Forest Service, Parks Canada and several Canadian universities. BERMS is the flagship flux station of the Fluxnet-Canada Research Network, a new national network that is studying the influence of climate and disturbances on carbon cycling in forest and peatland ecosystems. The BERMS region in central Saskatchewan has become a "super-site" for collaborative research, as the tower network and auxiliary observations provide a research database suitable for other environmental studies. The BERMS data are being used to strengthen our understanding of the key processes that control the forest's carbon and water cycles, including disturbance by fire and harvest, climate warming and drought.

ADAPTATION AND IMPACTS

HISTORICAL AND FUTURE CLIMATES FOR THE ASSESSMENT OF ENERGY SECTOR IMPACTS IN CANADA

The MSC is the key partner in the project "Historical and future climates for the assessment of energy sector impacts in Canada", funded by the Program on Energy Research and Development. The project's main objective is to develop a nationally-consistent set of energy sector scenarios of historical and future climate that are made available to impact researchers/users. These scenarios will address the needs of energy sector researchers and decision-makers and will be consistent with other sectoral impacts information being developed within the Canadian Climate Impacts Scenarios (CCIS) Project.

A web-based workshop, "Climate scenarios for the Canadian energy sector", was held and a synthesis report has been prepared by the MSC, based on the discussions at the workshop. In order to facilitate analyses of historical climate data and construction of scenarios, statistical software STECA (Statistical Tool for Extreme Climate Analysis) has been developed. The MSC analyzed the historical climate of 466 stations; this analysis is available on the CCIS website.

ref: http://www.cics.uvic.ca/scenarios/index.cgi?introduction

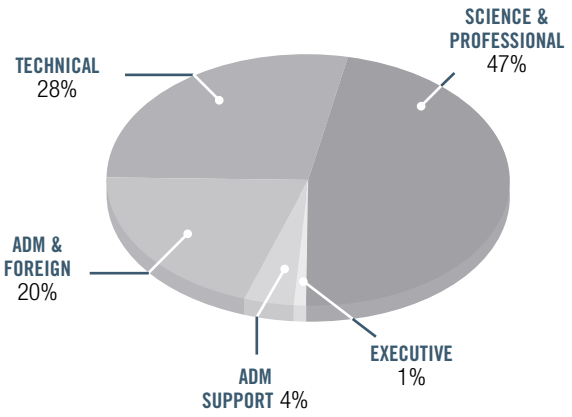
CREDIT: MSC

Flux tower at the BERMS Old Jack Pine site.

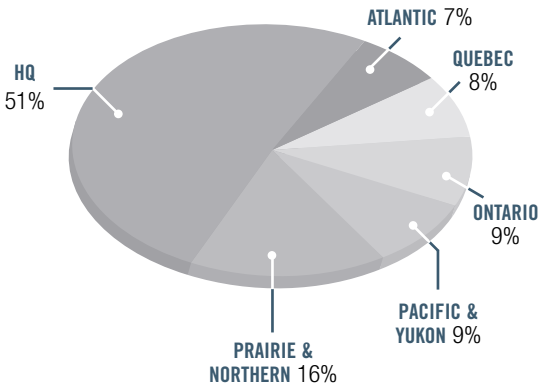
VI. OUR PEOPLE

DEMOGRAPHICS

MSC WORKFORCE BY CATEGORY



MSC WORKFORCE BY REGION



TRAINING AND DEVELOPMENT

SCIENCE-OPERATIONS CONNECTION

The Science-Operations Connection was held in Toronto in February 2004. The forum was attended by over 120 operational meteorologists, MSC managers and atmospheric research scientists from across Canada. The goals of the forum, second of its kind, included developing a common vision amongst researchers, forecasters and managers on the role and connections between the MSC's new National Labs and the new Storm Prediction Centres. The forum allowed operational meteorologists and research scientists to communicate what they need from each other, and what is needed from MSC management to make possible the connection between operational meteorology and research. The Connection was a success, a knowledge-sharing experience for both operational meteorologists and researchers.

ICE SAFETY AND RESCUE TRAINING

MSC – Ontario Region has been collecting water level and stream flow data for nearly 100 years. Safety training to help deal with the work's hazards and promote a safe work environment is an ongoing part of the job. To this end, the Ice Safety and Rescue course was held in 2003-2004. The course included classroom and field training; the former included information about hypothermia and body responses and techniques for self rescue and group rescue. The field component included performing self rescue, rope and pulley setup and team rescues.

CREDIT: MSC – ONTARIO REGION

MSC technologist attempts a self rescue with ice picks.

CREDIT: R. JACKSON

Nancy Cutler (centre) with staff.

AWARDS

Each year, dozens of MSC staff receive awards for their outstanding contributions. Following is a list of some of the individuals who received recognition in 2003-2004.

CREATION OF AWARD FOR ROLE MODEL AND MENTOR

The MSC celebrated the retirement of Nancy Cutler, Director General of the Policy and Corporate Affairs Directorate, in May 2003. Nancy's career with the MSC spanned 35 years, more than half of them in management. Nancy was active internationally through various activities of the WMO. Her outstanding contribution to meteorology in Canada was recognized in 1998, when she was awarded the prestigious Patterson Medal for Distinguished Service. At her retirement ceremony, Nancy was named the first recipient of the Nancy B. Cutler Award for Women in Science and Technology, a special award created in her honour to recognize efforts in promoting, encouraging and mentoring women in science and technology.

EXTERNAL AWARDS

SETAC AWARDS FOR MSC SCIENTISTS

Two MSC research scientists have been recognized for their accomplishments:

- Dr. Tom Harner was named the 2003 recipient of the Society of Environmental Toxicology and Chemistry (SETAC) Roy F. Weston Award. This award is designed to encourage the advancement of environmental problem-solving and to encourage the professional development of young scientists in the field of environmental chemistry.
- Dr. Terry Bidleman's name was placed on the newly established Institute for Scientific Information website (www.ISIHighlyCited.com) as one of the world's most highly cited authors in the field of ecology/environment. This honour goes to less than one percent of all scientists and is based on citations from journal articles published between 1981 and 1999.

AWARDS FOR THE CHILDREN'S UV INDEX SUN AWARENESS PROGRAM

The Canadian Dermatology Association presented Environment Canada and Health Canada with its 2003 Public Education Award for the Children's UV Index Sun Awareness Program. Launched in 1998, the program teaches students how to use the UV Index to minimize the risk to their health from solar ultraviolet radiation and educates students on the relationship between UV radiation and ozone depletion, climate change and air quality. Each year, the program provides material on sun awareness to 14 000 elementary schools across Canada. In 2003-2004, 3 500 high schools were added, bringing the total number of students in the program to 150 000.

The program was also a recipient of the 2004 Stratospheric Ozone Protection Award from the US Environmental Protection Agency, in the "corporate/government/military" category, for "protecting children from overexposure to ultraviolet radiation".

PUBLIC AWARENESS AWARD FROM THE INSTITUTE FOR RESEARCH IN CONSTRUCTION

In November 2003, Brad Bass of the MSC received the Institute for Research in Construction (IRC) Public Awareness Award for his participation in two Green Roof Infrastructure projects to evaluate the benefits of green roof infrastructure. Brad assisted in writing proposals, making presentations and was responsible for modelling the impact of green roofs on the urban heat island and energy consumption. His team also developed a semi-empirical model of roof storm water runoff. The award recognizes the role that this research has played in promoting a broader awareness of the IRC's activities and acknowledges the contribution that Environment Canada has made to this research activity.

US COAST GUARD AWARD

Yves Sivret, an Ice Service Specialist with the MSC, received a citation and medal from the US Coast Guard, a rare honour for a non-American civilian. Yves served as the ice specialist aboard the *USCGC Healy* during a scientific research mission in the Canadian Arctic during summer 2003. His work was cited as a credit to both the Canadian Ice Service and the joint efforts of Canada and the US in the Arctic.

2003 PRIZE WINNERS, THE CANADIAN METEOROLOGICAL AND OCEANOGRAPHIC SOCIETY

- Ron Hopkinson, formerly of Prairie and Northern Region, received the Dr. Andrew Thomson Prize in Applied Meteorology for his outstanding improvements to climatological applications of meteorological and hydrological data in addressing Canadian environmental concerns and for sharing his knowledge and expertise with others for the benefit of scientific research in Canada.
- Michael Schaeffer of Prairie and Northern Region received the Rube Hornstein Medal in Operational Meteorology for his pioneering work in marine wind forecasting and his data visualization methods for winds, which have been adopted by forecasters across Canada.
- George J. Boer of the Atmospheric and Climate Science Directorate was appointed a Fellow of the CMOS in recognition of his long-standing research in hydrometeorology, climatology and contributions to Canadian and international science and service.
- The Patterson Distinguished Service Medal is awarded by the MSC to residents of Canada for outstanding service to meteorology. Dr. Hal Ritchie, a research scientist with the MSC, is the 2003 recipient of the award. He is recognized in Canada and internationally for his extensive work on the application of semi-Lagrangian techniques in atmospheric models. Dr. Ritchie has led the Atlantic Environmental Prediction Research Initiative that is responsible for a number of innovative developments including the operational storm surge prediction hurricane reconnaissance programs.

INTERNAL AWARDS

HEAD OF THE PUBLIC SERVICE AWARD

Ten MSC employees who developed a new automated tool for generating forecast products received one of the Public Service of Canada's most prestigious awards in December 2003. The Head of the Public Service Award recognizes those who demonstrate team work, service, innovation, ethics and a dedication to valuing others.

The MSC has spent more than 10 years designing and improving SCRIBE, a computer application that can automatically generate a suite of forecast products based on input from Numerical Weather Prediction models and observations and forecaster expertise.

SCRIBE output is produced in digital format and allows the MSC to generate many types of forecasts, from public to marine, simultaneously in both official languages. SCRIBE is currently being implemented as one of the main production tools at MSC forecast offices in the regions. Input from the operational forecasters who use it has been an essential and invaluable part of the development of this ground-breaking technology.

CITATIONS OF EXCELLENCE

David Aihoshi, Marielle Alarie, Jean-Michel Alvarez, Martin Bartczak, Ed Becker, Yvonne Bilan-Wallace, Phil Blagden, Roger Bouffard, Gilles Brien, Jeff Brook, Sandra Buzza, Gilles Coulombe, Patrice Courbin, Rob Cross, Nancy Cutler, Réal Daigle, Frédéric Deschênes, François Dion, David Etkin, Indra Fung Fook, Yves Gagnon, Tim Gaines, René Héroux, William Horrock, Victoria Hudec, Edward Hudson, Sharon Jeffers, Kent Johnson, Grace Koshida, Ross Klock, Rob Kuhn, Luc Lamontagne, André Langlais, Ron Lee, Abdel Maarouf, Heather Mackey, Paul Makar, Roberta McCarthy, Robert Michaud, Mike Moran, Linda Mortsch, John Mullock, Jean Paquet, Serge Pelletier, Jean Richard, Bob Robichaud, Glenn Robinson, David Schmidt, Joseph Shaykewich, Marjorie Shepherd, Gilles Simard, Pierre Ste-Croix, Roger Street, Andrew Teakles, Pierre Tourigny, Bryan Tugwood, Bob Vet, Glenn Vickers

CREDIT: M. BOUCHER

First row (seated): Guylaine Hardy, Reine Parent, Claude Landry, Michel Nadeau

Second row (standing): Alex Himelfarb (clerk of the Privy Council and Secretary to the Cabinet), Richard Verret, Gilles Babin, Jacques Marcoux, Denis Vigneux, Luc Pelletier

Absent: Franco Petrucci

VII. SELECTED PERFORMANCE MEASUREMENT AND FINANCIAL INFORMATION

PUBLIC OPINION RESEARCH

The MSC regularly consults its clients, including the general public, through surveys and focus groups. Results of these consultations are used to ensure that MSC products and services meet public and client needs and expectations and to determine if changes or improvements are necessary. The 2002 survey that assessed Canadians' needs and satisfaction with MSC products and services will be repeated in 2007, in support of the government's Service Improvement Initiative.

PRODUCT VERIFICATION AND PERFORMANCE MEASUREMENT

The MSC has many years' worth of data that it uses to determine the accuracy of its temperature forecasts at 118 select cities. The following graphs demonstrate that the MSC has achieved steadily increasing accuracy of these forecasts for the past several years.

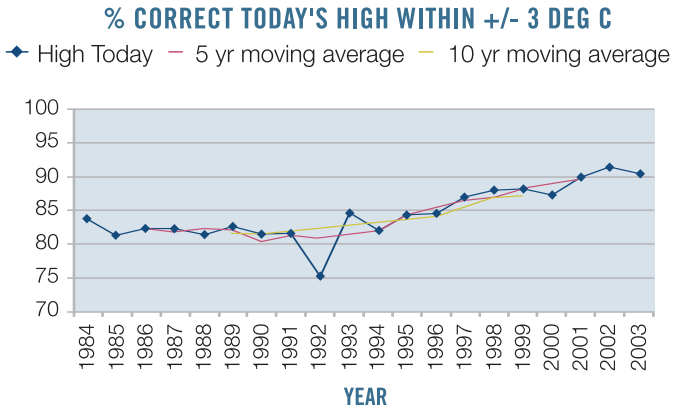


FIGURE 1: Percent correct of official public forecast high temperature for today to within plus/minus 3 degrees Celsius of observed values, at 118 stations across Canada, for years 1984-2003. The 5 and 10 year moving averages have the effect of smoothing out year-to-year variability to reveal steadily increasing accuracy.

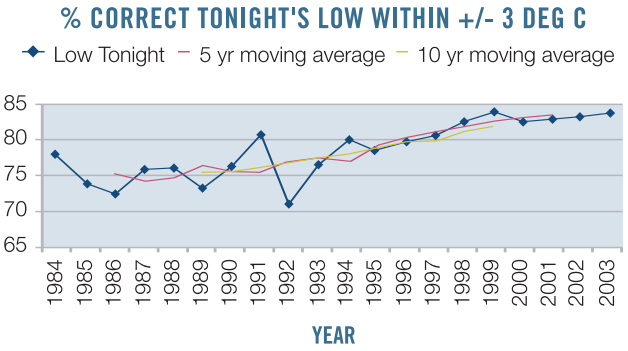


FIGURE 2: Percent correct of official public forecast low temperature for tonight to within plus/minus 3 degrees Celsius of observed values, at 118 stations across Canada, for years 1984-2003. The 5 and 10 year moving averages have the effect of smoothing out year-to-year variability to reveal steadily increasing accuracy.

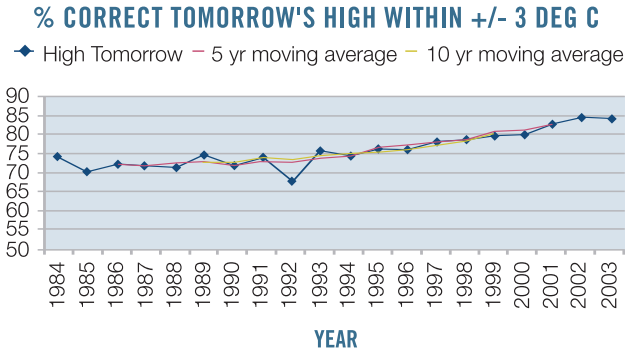


FIGURE 3: Percent correct of official public forecast high temperature for tomorrow to within plus/minus 3 degrees Celsius of observed values, at 118 stations across Canada, for years 1984-2003. The 5 and 10 year moving averages have the effect of smoothing out year-to-year variability to reveal steadily increasing accuracy.

A much more comprehensive system of verification for all forecast regions across Canada was developed and implemented in 2003-2004. It includes statistics for the accuracy of other weather parameters such as precipitation and wind. As we compile data over the coming months and years, Canadians will be able to understand the accuracy and performance they can expect from the MSC no matter where they live in this vast country.

PERFORMANCE MEASUREMENT OF SEVERE WEATHER

An automated system to report on the accuracy of summer severe weather warnings became operational in 2003-2004. Verification figures are now available for 2001 and 2002. Once data for 2003 and 2004 are collected and analyzed, the MSC will be able to inform Canadians of the accuracy and false alarms rates of the warning program, as well as the average lead time they can expect for events such as severe thunderstorms and tornadoes.

TECHNICAL PERFORMANCE

It is very important to measure the availability of systems for a 24 hour-a-day, seven day-a-week operation like the MSC. Availability of systems is critical to our obligation to provide Canadians with advanced warnings of weather and other environmental hazards, as well as the basic weather information that they need.

Availability of supercomputer systems was above the 97 percent performance benchmark for all months of 2003. Overall availability was well above the 97 percent target rate.

OTHER FEEDBACK METHODS

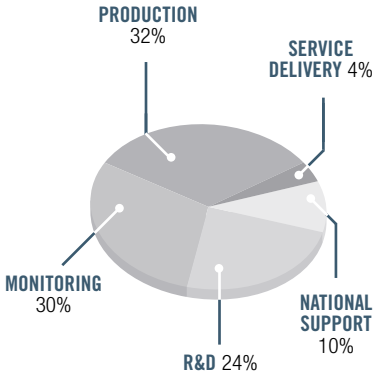
The MSC successfully responded to over 40 000 inquiries received via its website and national 1-800 enquiry line (1-877-789-7733). Approximately 99 percent of inquiries were received via the MSC “weatheroffice” website. The majority of inquiries pertained to areas such as public forecasts, weather warnings and severe weather and archive data.

FINANCIAL INFORMATION

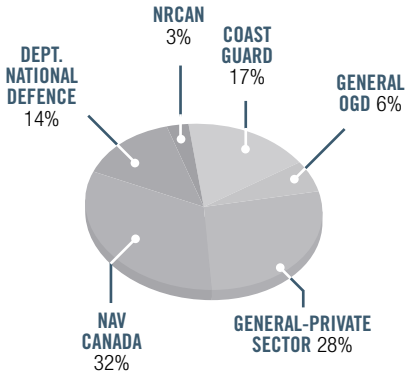
MSC ORGANIZATION TOTAL EXPENDITURES FOR 2003/2004

	SALARY	OPERATING	CAPITAL	GRANTS & CONTRIBUTIONS	TOTAL
MSC Atlantic	9,156,681	4,062,190	615,887		13,834,758
MSC Quebec	11,631,847	5,568,644	1,151,051	210,000	18,561,542
MSC Ontario	12,550,483	7,316,042	804,240		20,670,765
MSC P&N	22,357,854	15,303,344	5,455,482	29,550	43,146,230
MSC P&Y	12,157,146	6,511,106	1,082,864	80,000	19,831,116
MSC HQ	68,057,526	56,979,554	13,791,450	6,369,980	145,198,510
TOTAL	$135,911,537	$95,740,880	$22,900,974	$6,689,530	$261,242,921

MSC EXPENDITURES BY FUNCTION 2003/04

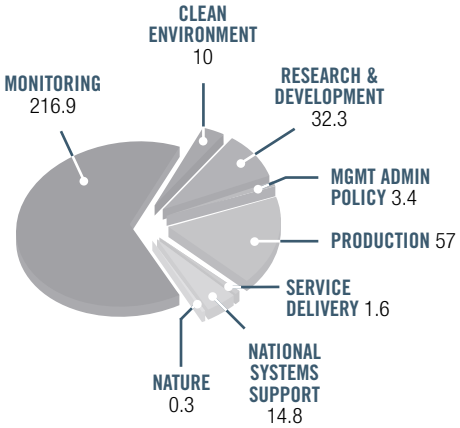


MSC REVENUE BY CLIENT 2003/04



HISTORICAL VALUE, MSC ASSETS, MARCH 2004

(assets valued over $10 000) values in $ Millions



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