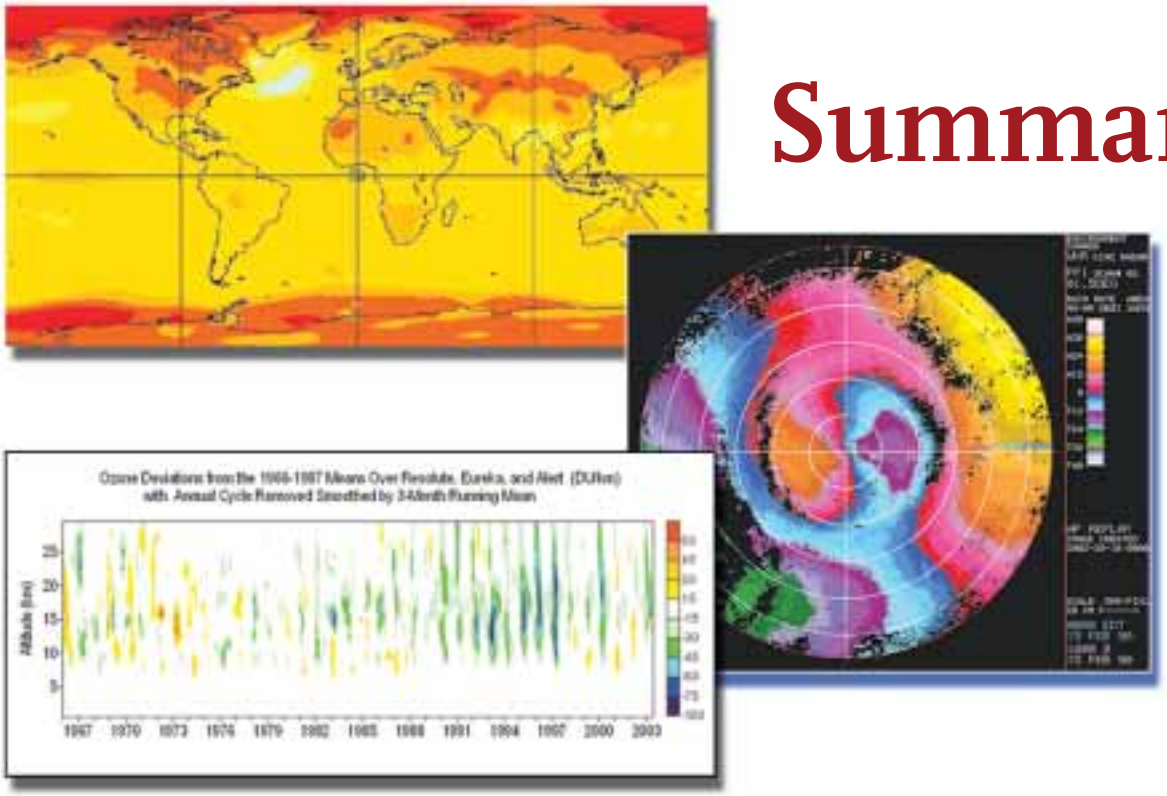
Environment Canada | Environnement Canada
Meteorological Service of Canada | Service Météorologique du Canada

Strategic Plan 2003-2012

Research and Development Program



Summary

MSC

Canada

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MESSAGE FROM THE DIRECTOR GENERAL

In 2001, an international Peer Review Panel found that the MSC Research and Development (R&D) Program was meeting the needs of clients with a high level of excellence – we led the world in some areas and in other areas, our R&D was world class or the best available in Canada. One of the recommendations of the Panel was that the MSC R&D program would benefit from developing a strategic plan.

This document is in response to the Panel's recommendation. It will challenge us scientifically and guide our scientific and program-related decisions in the short and long term. It will help staff to see where we are going and enable them to participate in our exciting future. This plan allows the rest of the MSC and the Department to see how a strong internal R&D program can help them to realize ***their*** *long-term goals, and at the same time will help them to identify what we in turn need to achieve* ***our*** *goals. It will also provide stakeholders with a clear vision of our future directions, enabling them to participate in initiatives that will help us to achieve our strategic objectives.*

In the next few decades, the atmosphere, and its underlying surface will go through unprecedented changes, partly because of humankind's activities, and partly due to its natural variability and evolution. The loading of the atmosphere with greenhouse gases, ozone depleting substances, particulate matter, toxics, etc., combined with the increasing human footprint on the earth's surface (deforestation, tilling, irrigation, urbanization), will have a profound impact on our environment.

Some of those impacts are so severe that not only are they threatening to the survival of major ecosystems, but in some catastrophic scenarios, to humankind itself. For example, climate change, ozone depletion, and air pollution all affect our health and well-being. Determining how the atmosphere and water

Dr. Michel Béland,
Director General, Atmospheric & Climate Science Directorate

systems will respond to these changes, and whether or not we can eventually restore them to a state that poses no threats, or, at the very least, developing adaptation and mitigation strategies, will require solving some of the most challenging scientific problems of the 21st century.

As our appreciation of the complexity of the underlying science issues grows, the investigations will become more and more multidisciplinary in nature, necessitating a more holistic and team approach. An example of this is the broadening range of skills and capacity needed to support and improve climate models of the atmosphere. Over the next ten years, the amount of earth observation data that will be available to atmospheric scientists will increase by about five orders of magnitude. Computing and telecommunication capacity will also significantly increase, allowing for more accurate simulations of the atmosphere and the environment. Many exciting multidisciplinary field experiments, some global in nature, such as the International Polar Year, GEO or THORPEX, will

MESSAGE FROM THE DIRECTOR GENERAL.... CON'T

result in the creation of databases that are vital for the validation of theories and model scenarios.

Increasingly, climate, air quality and weather modelling systems will be tightly coupled, move to increasingly finer scales, and rely on complex multivariate data assimilation systems. There will be a tremendous increase in the resolution of data (spectral, temporal, and spatial), and in the generation of simulation products, as well as a shift in prediction paradigms (deterministic to probabilistic). These changes will greatly enhance our capacity to solve some of the challenges, and develop policies and services more relevant to the needs of policy and decision makers.

The internal environment, in which we conduct our activities, will also evolve significantly. The changes are already apparent. There is a strong push to increase the support to university-based research, sometimes at the expense of government conducted R&D activities. An optimal balance will ultimately be achieved, but the stresses during this transition will create interesting management challenges. Management also has the challenge of closely tying our R&D programs to the needs of our stakeholders, while at the same time nurturing and preserving a challenging and motivating research environment for scientists that is based on curiosity, passion and dedication to excellence, which is their fundamental motivation.

Atmospheric science issues are becoming increasingly globalized and more complex. They require so much data that they cannot be tackled by any individual country without stressing their research capacity to the limits. Canada will have to increase its contribution to the resolution of these issues, particularly in regards to data. This will enable Canada to keep its largely free access to unlimited sources of data and knowledge that are essential to solving its own national environmental challenges. An indirect consequence of this trend will be the increasingly stiff competition for the best scientific talents worldwide. The 'graying' of our scientific population will make this a greater challenge. The organizations that succeed will be those who manage to maintain an exciting and rewarding work place for their employees, and who are able to provide them with state-of-the-art infrastructure and competitive compensation.

This plan has carefully considered the above stressors and factors of change. It assumes that knowledge of the atmosphere, hydrosphere and cryosphere and how they are changing is, and will remain, of strategic importance to decision-makers – Canadians, their governments, academia and industry. Through this plan, we will provide the sound science, data, information and advice needed to ***understand and reduce the vulnerabilities*** *to our social, economic and environmental systems* ***due to our changing environment.***

The challenges in this plan are exciting and I anticipate meeting these challenges enroute to achieving our strategic objectives. I also look forward to watching the long-term evolution of the MSC based on its strong scientific foundation, and the evolution of the science and the R&D program in response to the needs of its clients and research partners.

THE STRATEGIC DIRECTION OF MSC'S R&D PROGRAM

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This summary outlines the strategic direction of the Meteorological Service of Canada (MSC)'s Research & Development (R&D) Program over the next 10 years. It is designed as an evolving tool to meet the strategic and near-term planning needs of the MSC R&D staff and management, and to help stakeholders understand and participate in our future directions. (The full plan is available at http://www.msc-smc.ec.gc.ca/acsd/index_e.html)

MSC R&D is delivered through a partnership between the MSC Headquarters science components and the atmospheric and related environmental science units in Environment Canada's (EC) Regions. The Atmospheric and Climate Science Directorate (ACSD) has a leadership role in defining and implementing the MSC's R&D agenda, its ethos and raison d'être, and ensuring the scientific excellence of the R&D program.

Driven by science excellence, MSC R&D's role is to ensure that Canada has the scientific capacity needed to: provide essential government services (e.g., weather data, forecasts and warnings; climate and air quality data, information and advice), and effectively respond to key environmental, health and safety issues such as climate change, ozone depletion, air quality and water quantity.

Since science operates on much longer time lines than services or policy, there is a corresponding need for a strategic plan that helps MSC make decisions about the longer term and ensures that we will continue to have the capacity to deliver the R&D and innovative solutions that are critical to federal policy and services.

WHERE IS MSC R&D GOING OVER THE NEXT 10 YEARS?

Over the next 10 years, MSC R&D will provide the science capacity that will lead to more informed risk-management decisions by ministers, Canadians, industry, policy-makers and other decision-makers. We will focus on atmospheric and related environmental research to improve risk management decision-making processes to increase opportunities and reduce the social, economic and environmental vulnerabilities caused by changes in the atmosphere and related environment, in both the short and long term. Our focus will be in areas that affect human health, energy, Canada's built infrastructure and key economic sectors.

What does this mean for MSC R&D? To address client issues in the important realm of risk management, we will use different strategies. For example, one strategy that MSC R&D will use is to move towards modelling in finer time and space scales and developing more comprehensive climate, weather and air quality models for short and long term prediction. This strategy has implications on what MSC R&D does in the areas of process research, data methods, data assimilation, modelling and applications. These in turn have implications on R&D skill sets, partnerships, data quality, computing power, storage capacity and equipment that we will need. Implementing our long-term strategies (detailed in Chapter 2) will have significant ripple effects on what we will do, how we will do it, and the future of the rest of the MSC.

WHAT IS OUR MISSION?

A mission statement allows staff to see how they contribute to the R&D efforts, it communicates the importance of our business, and it ensures that what we are doing is consistent with the departmental mandate and MSC's vision. Most importantly, it keeps our work and our resources focussed by defining our purpose.

Following significant deliberations, the ACSD Management Committee and Weather and Environmental Predictions Science Advisory Committee (WEPSAC) (which includes the MSC Regions), approved the following mission statement on January 27, 2003.

***The mission of MSC R&D is to develop, apply and provide unbiased, relevant and scientifically sound knowledge, advice, data and information, and build Canada's science infrastructure on the atmosphere and the related environment* so that:**

- The MSC and its collaborators provide accurate and useful products and services to the satisfaction of their clients.
- Domestic and international policy and decision-makers have the knowledge required to reduce emerging and existing social, economic and environmental vulnerabilities caused by a changing environment and economic development.
- Canada participates, influences and benefits from the unbiased and credible science needed to address domestic and global environmental issues.
- Canadians have the knowledge, awareness and understanding of atmospheric and related environmental issues which affect their health, safety and economic opportunities.

WHAT DOES THE MISSION STATEMENT IMPLY?

There are many implications of the mission statement – obviously we must have the capacity to deliver on the client needs specified above and work within the laws of Parliament and the principles/guidelines/directives of public sector management. But what else is ***implied*** by the mission statement about ***how*** we run the science program?

Based on the mission statement, there are four obligations on ***how*** we run the science program. These obligations agree well with our values and principles.

- ***Achieving science excellence*** – to produce high quality, leading edge, credible and unbiased science which is relevant to our clients' needs and makes us leaders in Canada.
- ***Managing intellectual capital*** – to stimulate R&D in Canada, to engage the needed collaborations, develop the right skill sets, protect intellectual properties and balance creativity, curiosity and innovation with the need for mission-driven research.
- ***Delivering a national program*** – to ensure a nationally coherent program which can meet the changing and Regional specific needs of Canadians and our other clients.
- ***Encouraging advocacy*** for atmospheric science in the context of managing risks to human health and safety, domestic security, economic efficiency and ecosystem health.

The scale and scope of atmospheric and related environmental R&D makes national and international collaboration essential. Today's issues require multidisciplinary and multi-scale solutions which can be applied multilaterally.

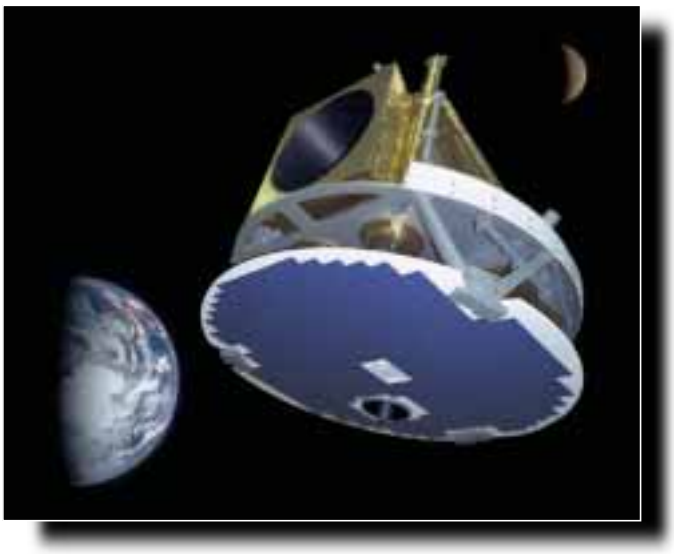
STRATEGIES AND STRATEGIC OBJECTIVES 2

Within the context of the MSC R&D mission, the 10-year strategic plan moves us towards achieving the following three strategic objectives:

1. Support risk-based decision making affecting Canadians' safety and security, their economy and the environment due to high impact atmospheric and related environmental events (weather, air quality, hydrologic and oceanographic) on the scale of minutes, days and weeks.
2. Support risk-based decision making affecting Canadians' security and health, economy and the environment due to changes and variability in the atmosphere and related environment on the scale of weeks, years and centuries.
3. Provide a coherent and consistent picture of the present and past states of the atmosphere and related environment.

In moving towards these strategic objectives, MSC R&D will see its role increase in the following areas:

- ***Technology transfer (Outgoing)*** – Technology transfer includes presenting papers at various (domestic and international) fora, helping to implement new process research, participating in model intercomparisons, and assisting in developing new forecast and model applications. Technology transfer will become more important as we move to new measurement technologies, finer and more comprehensive models, respond to the diverse and growing need for more environmental predictions and applications, and will contribute to the success of the MSC transition.
- ***Technology transfer (Incoming)*** – The MSC R&D program benefits from many domestic and international R&D networks. Through these networks we frequently exchange knowledge, data and expertise. Technology transfer will become more important as academia becomes more involved in public policy issues and MSC develops more research networks to meet the needs of the new national labs.
- ***Scientific Applications*** – MSC R&D will improve its capacity in environmental prediction, especially in areas that affect health, safety, security, economy and environment.
- ***Communicating Science*** – MSC R&D will engage clients (including the public and policy-makers) to help them understand their sensitivity to uncertainty, and develop a mutual understanding of risks, needs and the degree to which science can address their issues. MSC R&D will also encourage advocacy for atmospheric science especially in areas related to human health and safety, domestic security, economic efficiency and ecosystem health.
- ***Science of Data*** – Data is a core need of all MSC programs, including R&D. As computer models go to finer time and space scales and become more comprehensive, MSC R&D will require more types of data measured at increasingly finer space and time scales and the ability to assimilate those data in predictions and analyses. Resolving the data density, quality and diversity issues will require increased collaboration, new technologies and approaches to measurement, a capacity to exploit the explosion of remotely sensed data, and a means to define the social and economic value of data.
- ***Multidisciplinary solutions and synergies*** – As scientific issues grow more complex and inter-related, the need for multidisciplinary solutions increases. The MSC is fortunate to have meteorology, climate, ice, and atmospheric chemistry R&D, along with capacities in science assessment and impacts and adaptation



under one roof. However, there is a need for more coordination between the main research areas (e.g., process research, data methods and assimilation, modelling, etc.) and between the disciplines, especially for issues such as high impact weather, toxics, climate change, oceans, ice and the Arctic. In addition, MSC R&D needs to create more synergies with its monitoring colleagues to advance observing systems within the MSC.

- ***Partnerships and Collaborations*** – With the growing scope and scale of atmospheric and related environmental R&D, international and domestic collaborations are essential. While partnerships are a valid means to share expertise, data and other resources, we need to examine all existing and potential partnerships with our eyes wide open to the benefits and costs of such arrangements. Our partnerships with Canadian universities will increase because the Canadian government is increasingly using mechanisms such as the Canadian Foundation for Climate and Atmospheric Science (CFCAS) and the Canadian Foundation for Innovation (CFI) to fund policy relevant scientific research in universities.
- ***Ice research*** – As we move towards higher resolution models and do more research on climate change in the Arctic, there will be an increasing need to integrate more ice research into the MSC R&D program. This research will feed into policy development, services and provide knowledge and data for other research programs as well.

KEY ISSUES INCLUDED IN THE STRATEGIC OBJECTIVES

Each of the strategic objectives requires coordination across the various R&D program elements and each addresses several key issues.

Strategic Objective	R&D Program Elements	Key Issues to be Addressed
1. Risk-based decision making – minutes, days and weeks	weather, water, air quality, science assessment, knowledge and technology transfer, outreach and education	High impact weather (health, safety, security), extreme hydrological events, water quality, smog, stratospheric ozone, biometeorology, science capacity, national lab implementation, Arctic
2. Risk-based decision making – weeks, years and centuries	weather, climate, air quality, water, science assessment, impacts and adaptation, knowledge and technology transfer, outreach and education	High impact weather, climate variability and change, smog, acid rain, toxics, water availability, cryosphere, health, biometeorology, security, Canada's infrastructure, energy, agriculture, environmental assessment, ecosystem health, science capacity, Arctic
3. Past and present states of the environment	all	Data density, quality and diversity in support of strategic objectives 1 and 2, new observing technologies and strategies, data assimilation and analytical tools, new analytical capabilities

NOTE: weather, climate, air quality and water research include data methods, data assimilation, process research, modelling and applications

STRATEGIC OBJECTIVE

"Support risk-based decision making affecting Canadians' safety and security, their economy and the environment due to high impact atmospheric and related environmental events (weather, air quality, hydrologic and oceanographic) on the scale of minutes, days and weeks."

High impact events directly affect the health, wealth and security of all Canadians.

High impact events (e.g., heat waves, tornadoes, hail, ice storms, floods, poor air quality and drought) directly affect the health, wealth and security of all Canadians, our economic efficiency and competitiveness, and environmental quality. Whether a high impact event becomes a human catastrophe depends on the integrity of the essential infrastructure (electricity, telecommunications, roads, etc), the capacity of first responders and the resiliency of the communities.

Sound science provides the foundation for effective policies and the integrity of essential government services.

Sound science provides the foundation for the critical policies and essential services needed to manage the risks of high impact events. The importance of atmospheric and related environmental R&D increases as Canadians become more vulnerable to changing weather and environmental conditions. Canada's change in vulnerability arises as the population concentrates in urban areas, the infrastructure ages and new technology creates complex but vulnerable production and delivery systems.

Since the atmosphere and hydrosphere can transport various chemicals and other hazardous materials vast distances, risks can come to Canadians from afar. Economic development and increased energy use and production around the world contribute to the risks and vulnerabilities of Canadians.

Risks can be from several cumulative events and originate outside of Canada.

The highest risks are not usually from a single high impact event, but from several cumulative events. These events can have trickle-down effects on social and economic systems for years to come. Examples of cumulative events include:

1. The prolonged heat wave (likely combined with poor air quality) that caused some 11,000 premature deaths in France in 2003.
2. The Walkerton water-borne disease outbreak (caused by cumulative rainfall events coupled with infrastructure problems and farming practices) that killed over 20 and sickened some 2200 people.
3. The 2000+ premature deaths in Ontario every year due to poor air quality (some of which is transborder and is exacerbated by high heat).

Canada must have the science capacity to deal with multidisciplinary issues on various time and spatial scales.

To manage the risks to its social, economic and environmental systems, Canada needs the science capacity to provide the foundation for, and integrity to, essential government services and effective policy advice. That science capacity must deal with multidisciplinary issues on many time and space scales and consider the complex chemical and physical interactions at various space scales.

Through this strategic plan, ***MSC R&D, in collaboration with others***, will provide sound scientific solutions (knowledge, data, advice, etc.) supporting client needs in the form of:

- Increased lead time and accuracy for high impact events such as severe weather, poor air quality and drought; real-time prediction and monitoring of precipitation and antecedent conditions at the watershed level.
- Improved predictions of air quality conditions at a smaller scale (regional or city scale); inclusion of more chemical species in the predictions.
- Short and long-range dispersion predictions for hazardous substances in the air and inland waterways and radiological releases.

- Extreme weather climatologies and statistical tools (extreme precipitation frequency, intensity/duration curves, etc).
- Vulnerability assessments, adaptation strategies (emergency readiness, building codes) and advice to promote resilient communities now, and under a climate changed scenario.
- Predictions of situations which could produce increased mortality based on weather and air quality factors.

In collaboration with others, MSC R&D will move down certain "roads" and invest in specific areas defined by the following high level strategies.

High Level Strategies for Strategic Objective

- Move to finer time and spatial scales for predictions and analyses.
- Shift to probabilistic outputs.
- Increase capacity in environmental prediction (e.g., applications to agriculture, water quality, forestry).
- Promote the need for expanded lists of environmental parameters to be measured on finer space and time scales. Exploit all available data.
- Move towards more integration of models and observations.
- Engage clients and stakeholders to develop a mutual understanding of risks, needs, and the degree to which science can address their issues.
- Transfer knowledge and technology for mesoscale prediction and analysis to the Regions.
- Define and communicate social and economic vulnerabilities and potential adaptation strategies.
- Demonstrate the social and economic value of improvements in high impact prediction.
- Transfer knowledge, technology, data and information for all atmospheric issues over a wide range of depths and complexities.

STRATEGIC OBJECTIVE

2 "Support risk-based decision making affecting Canadians' security and health, economy and the environment due to changes and variability in the atmosphere and related environment on the scale of weeks, years and centuries."

Physical and chemical processes and socio-economic impacts link the six key environmental issues.

Currently MSC R&D is addressing six key environmental issues: climate change and variability, smog, acidification, stratospheric ozone depletion, hazardous air pollutants (e.g., mercury) and long-range transport of atmospheric pollutants. These are not mutually exclusive issues. For example, science has linked emissions from energy production and use to acid rain, smog, climate change and mercury in the environment. Stratospheric ozone depletion influences climate change and vice versa.

We can build on the physical and chemical linkages and the socio-economic impacts of climate variability and change to help address other air issues.

An intricate web of issues requires multi-scale, multidisciplinary and multilateral approaches

Climate change and variability impact on land use, ecosystem health and water supply. Changes in land use affects community planning, migration routes, habitat availability and water quality. Our changing environment affects the spread of animal diseases, some of which affect humans. The six original environmental issues have created an intricate web of interrelated issues. In addition, there are local, regional and global aspects to these environmental issues. Therefore, we need a collaborative, integrative approach to ensure that the R&D solutions are multi-scale and multidisciplinary and can be applied multilaterally.

Canada's changing environment affects our health, wealth and environment.

Weekly, seasonal and longer term fluctuations in the climate, ozone layer, atmospheric chemistry and hydrology create short and long term threats to our health, economic efficiency and competitiveness and environmental quality. In fact about $^1/_7$ of Canada's GDP is weather and climate sensitive, including key economic sectors such as agriculture, forestry and construction. The quality of Canada's critical infrastructure (telecommunications, roads, bridges, buildings, etc.), and our electrical demands are also directly influenced by our changing atmosphere and the related environment. These and other sectors require more complex and sophisticated decision-making systems to manage their risks. To better manage the risks and become more competitive, these sectors require tailored environmental information based on sound science.

Sound science provides the foundation for effective policies and the integrity of essential government services.

Sound science provides the foundation for essential policies and services needed to minimize Canada's social, economic and environmental vulnerability to our variable and changing environment. Through process research, model development, vulnerability assessments, technology transfer and engaging others through collaboration and advocacy, MSC R&D can help develop adaptation strategies to mitigate the impacts, minimize the risks and identify opportunities.

Through this strategic plan, ***MSC R&D, in collaboration with others***, will provide sound scientific solutions supporting client needs in the following areas:

- Ability to detect, attribute and understand various climate change processes (e.g., involving boreal and wetland systems, tundra, agricultural activities, etc.).
- Provide regional scale climate change scenarios and advice on vulnerabilities, impacts and adaptation

To achieve strategic objective 2 and develop the scientific solutions needed by clients, MSC R&D, in collaboration with others, will employ the following high level strategies.

High Level Strategies for Strategic Objective 2

- Move to finer time and spatial scales for predictions and analyses.
- Shift to probabilistic outputs.
- Increase capacity in environmental prediction.
- Shorten developmental paths for new operational products.
- Engage clients and stakeholders to develop a mutual understanding of risks, needs and the degree to which science can address their issues.
- Move to a science model based on increased collaboration, science networks and advocacy.
- Define and communicate social and economic vulnerabilities and potential adaptation strategies.
- Develop capability to demonstrate the social and economic value of improvements in high impact prediction.
- Develop the capacity to transfer knowledge, technology, data and information for all atmospheric and related environmental research issues on a wide range of depths and complexities.

in several key areas such as: land use change management; the Arctic (sea ice, permafrost), the hydrological cycle (with applications to water supply, extremes, water apportionment, water export, transportation, irrigation, habitat, etc); frequency and intensity of extreme events; and, coastal infrastructure.

- Develop seasonal predictions in support of managing risks in key economic sectors (e.g., agriculture, energy and forestry).
- Assess the co-benefits of climate change (building on the physical and chemical linkages and socio-economic impacts of climate change to help address other air issues).
- Support the technology development and mitigation strategies needed to achieve Kyoto targets.
- Understand climate variability and change, and its impact on land use change, habitat loss and biodiversity.
- Produce coupled atmosphere-ice-ocean-land surface models.
- Model and understand contaminant cycling and accumulation in the atmosphere and terrestrial systems (e.g., mercury and persistent organic pollutants).
- Provide more accurate air quality predictions on a regional or city scale; include more chemicals in predictions and analyses.
- Support the development of Canada Wide Standards and transboundary agreements, the analysis of precursors to smog, the evaluation of emission reduction scenarios and domestic regulations, and monitor acid rain and air quality impacts on ecosystems.
- Develop photochemical air quality prediction models for regional airsheds.
- Carry out hydrological analysis for streamflow and transboundary water management.
- Monitor and predict drought.

STRATEGIC OBJECTIVE

3 "Provide a coherent and consistent picture of the present and past states of the atmosphere and related environment."

Observations are critical to sound science, essential services and policy development.

Data is a core need of the MSC, including the R&D program. Observations are essential to:

- Understanding the past and current behaviour of the atmosphere and related environment.
- Identifying new processes and new chemicals in environmental systems.
- Validating models.
- Predicting future behaviour of the atmosphere and related environment.
- Maintaining an archive or climatology to support applications and R&D.

Providing high quality data and data archives is essential to responding to the needs of policy developers and essential service providers, and addressing the first two strategic objectives.

Canada, as part of an integrated global monitoring system, is reducing its investments in data.

Canada is already part of an integrated global monitoring system comprising some 190 national meteorological and hydrological services and has data agreements with many agencies. While others (e.g., US, European Union) are investing in their systematic measurement networks, the MSC is reducing its networks in response to budget restrictions.

In achieving strategic objective 3 and developing the scientific solutions needed by clients, MSC R&D, in collaboration with others, will employ the following high level strategies.

High Level Strategies for Strategic Objective 3

- Lead and participate in collaborative programs (domestic and internationally) to improve observing strategies, evaluate measurement systems and better understand the behaviour of the atmosphere and related environmental elements.
- Promote the need to expand the number of environmental parameters to be measured on finer spatial and time scales.
- Engage clients and stakeholders to develop a mutual understanding of risks, needs and the degree to which science can address their issues.
- Develop high quality data sets to facilitate understanding the behaviour of the atmosphere in time frames ranging from last season to several centuries ago.
- Shorten the development path for assimilating new types of data.

There is a need to invest in new collaborations, new technologies and capacity to exploit remotely sensed data.

As computer models go to finer time and spatial scales and become more comprehensive (including more complex interactions within the environment), researchers (in Canada and abroad) will need access to more types of environmental data which are measured on finer spatial and time scales. Resolving the data density, quality and diversity issues will require increased collaboration (e.g., provinces and municipalities), new technologies and approaches to measurement, a capacity to exploit the explosion of remotely sensed data from various satellites, and a means to define the social and economic value of data.

Through this strategic plan, ***MSC R&D, in collaboration with others***, will provide sound scientific solutions supporting client needs in the following areas:

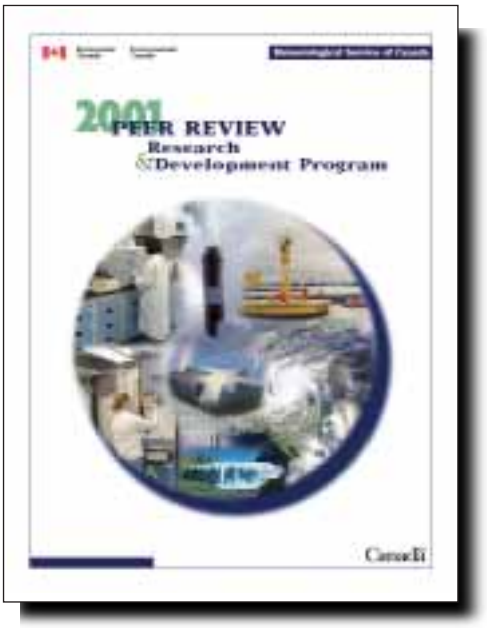
- Support MSC systematic monitoring networks by better integrating space and ground-based measurements, defining accuracy needs and managing the shift from in-situ to remotely based sensing.
- Make accurate measurements of water, snow and ice resources.
- Develop post-event analysis tools and tools to calculate the frequency, extremes and trends of high impact events.

3 VALUES AND PRINCIPLES

Values define what are important to us in the day to day running of the R&D program, and principles are deeply held beliefs by which MSC R&D will manage the program. Both guide managerial and staff behaviour in the decision making process. When gaps between these and our existing practices exist they increase risk to our staff, clients and collaborators.

Values

- We value ***scientific excellence.*** This means we promote creativity, encourage and recognize innovation, expect competence and are willing to take reasonable risks in pursuing excellence.
- We value ***straight talk.*** This means we promote openness, operate transparently and encourage innovative thinking and intellectual freedom even if it disagrees with existing views.
- We value ***responsiveness.*** We value staff and collaborators when they see a need and respond to it to the best of their ability, do their share, and honour their commitments.
- We value ***trust and integrity.*** This means that our relationships with staff and others will be based on confidence, fairness, respect and moral principles.
- We value people who ***"walk the talk"***. This means we value people when they follow through with their commitments and do what they say they will do.
- We value ***science.*** This means we encourage staff and collaborators to rigorously use the scientific method in creating knowledge that is relevant, credible, and politically independent.
- We value ***leadership.*** This means we encourage taking reasonable risks, taking a stand and demonstrating initiative.



We have agreed to adopt the SAGE (Science Advice for Government Effectiveness) ***principles*** (http://www.csta-cest.ca) with modifications to also reflect the service foci of MSC R&D. The desired outcome of these principles is to ensure that:

- Scientific knowledge used by government service providers and the science/expert advisory process is ***the best available at the time.***
- The ***uncertainties*** in our science can be properly identified, assessed and reported.
- New knowledge will be ***continuously evaluated*** for relevance, and any implications for previous advice will be assessed.
- Science linkages and shared agendas will be ***fostered with others*** within and external to government.
- The process of converting science advice into policy and services will be ***effective.***
- Research within government will remain ***open, independent and peer-reviewed.***

In this way, scientific knowledge from MSC R&D and others allows decision-makers (governments, policy-makers, Canadians) to make more effective decisions, minimize crises and unnecessary controversies, and capitalize on opportunities (e.g., economic productivity and competitiveness).

Currently, no gaps have been identified in MSC R&D's current practices and the above values and principles. Staff and managers will continue to monitor the situation through various committees, client feedback and the next peer-review. When gaps are identified, corrective targets will be set and monitored.

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