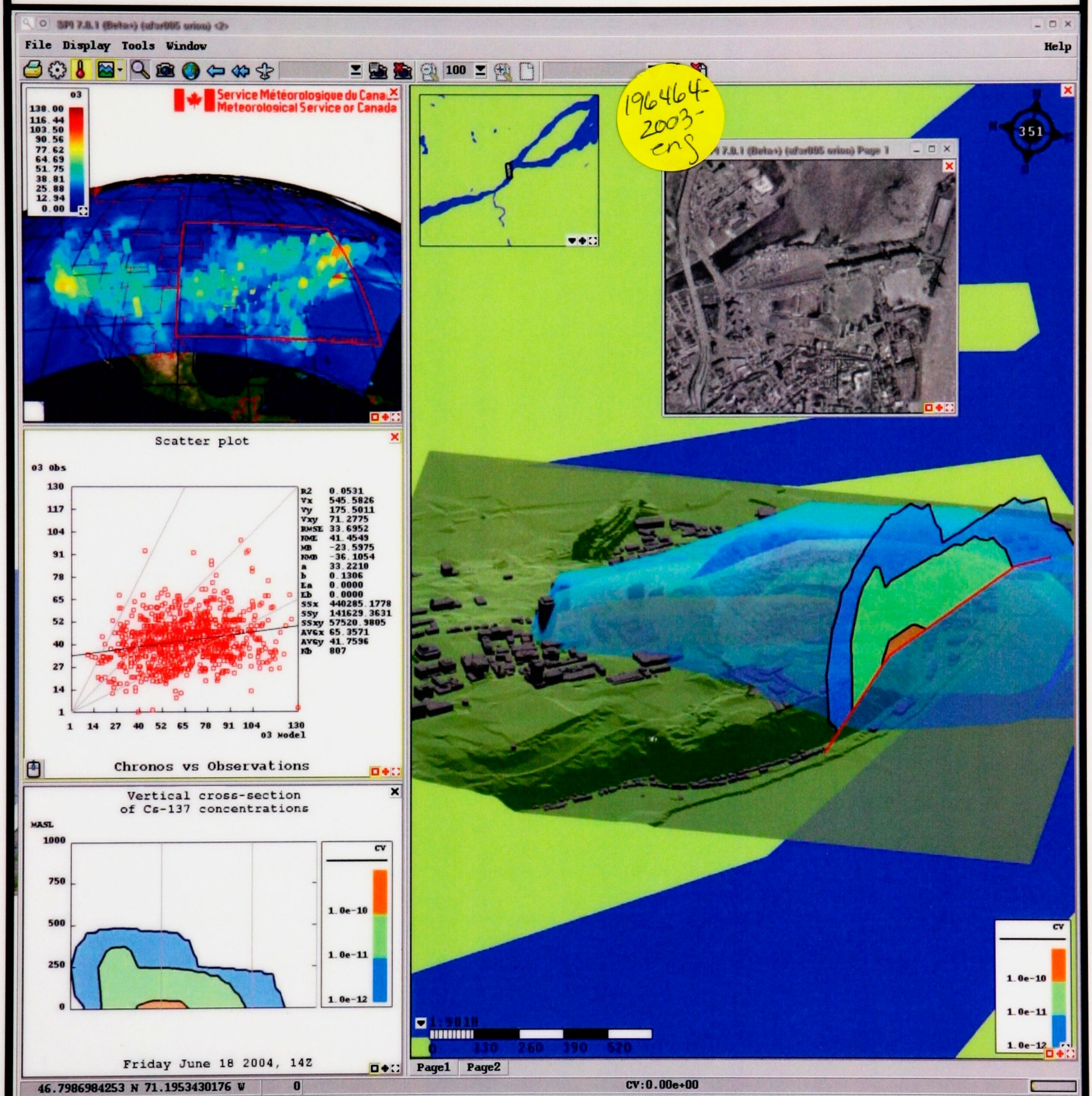
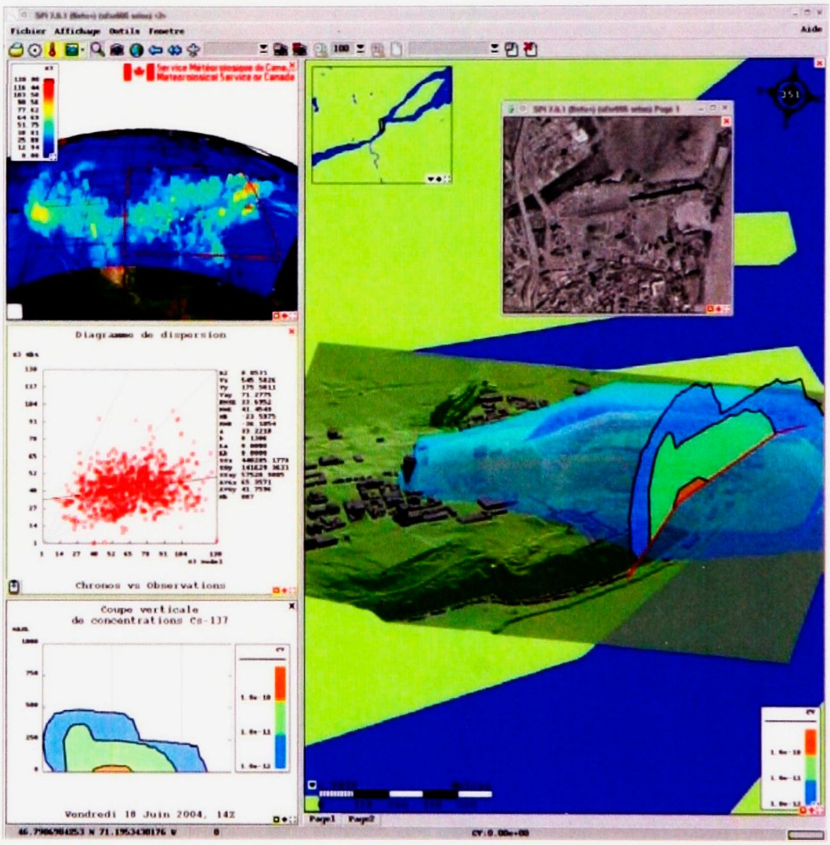
Canadian Meteorological Centre 2003 Annual Review



... new tools for new needs

Canada

The **Canadian Meteorological Centre** (CMC) is responsible for national meteorological and environmental forecasts and for the national telecommunications and data management systems. CMC also provides national and international support during environmental emergencies and natural disasters. The Centre gathers, archives, analyses and disseminates data related to climate, stratospheric ozone, ultraviolet radiation, air quality and water quantity and quality. The CMC plays a primary role in technology transfer to the Meteorological Service of Canada (MSC) regional offices. Some of the clients for this specialised information include Nav Canada, the Department of National Defence, other government departments and agencies, several airlines, the media and many private companies.



Vizualization and interactive data analysis tools are essential to the understanding of complex atmospheric processes. SPI (Spherical Projection Interface) is a powerful visualization application for meteorological and environmental data products developed at the Canadian Meteorological Centre for specialized applications. This software is one of the core elements of the real-time response to environmental emergencies, nuclear test ban treaty verification applications as well as for the research and development work on air quality modeling being done at the CMC, in MSC Regions and within the Air Quality Research Branch. Most of the air quality validation framework is based on the Data Analyser which includes different modules to analyze meteorological and environmental data. Through this application, the user can easily generate vertical profiles, time series, scatter plots and contingency graphs. An embedded calculator provides the possibility to do mathematical operations on fields in order to compute other statistics. SPI takes advantage of modules and databases developed over the years by other divisions at the CMC and the co-located RPN (Recherche en prevision numérique) division, and is fully integrated within CMC's operational environment. The Meteorological Service of Canada is currently involved in the development of an operational meteorological workstation graphical user interface through the NinJo consortium involving Switzerland, Denmark and Germany.

The above figure is a 3D urban topographic model, courtesy of Defence Research and Development Canada, Valcartier, PQ; SPI and SPI sub-components were developed thanks to the work of many individuals, including Jean-Philippe Gauthier, Serge Trudel, Michel Grenier, Yves Chartier, Stéphane Gaudreault, José Garcia.

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Message from the Director General

2003: A year of transition!

Dear Readers:

I am delighted to introduce the Canadian Meteorological Centre Review 2003.

At the Meteorological Service of Canada, the year was marked by a major ministerial announcement in March. There will be a substantial injection of funds, and a number of programs will be restructured. The result? We will be able to serve Canadians more effectively, but the enhancements will take a few years to complete.

For the CMC, 2003 was a year of transition. We had to devote considerable resources to rejuvenating our computers. The showpiece was undoubtedly the installation of the IBM supercomputer to replace the NEC SX-6. The project presented IT experts as well as researchers and development staff with a major challenge, because the changeover involved moving from the vector architecture of the NEC SX-6 to the superscalar architecture of the IBM P690. One of the articles in this issue of the Review talks about the workload that this changeover created for dozens of people. We also made significant changes in our Internet service. For our weather website, a more robust architecture, the consolidation of the Dorval and Vancouver sites and an increase in bandwidth enabled service improvements and allowed us to meet the unusually high demand due to Hurricane Isabel. We also improved the aviation weather website that we operate for Nav Canada. Finally, we signed an international collaborative agreement on the NinJo workstation software system, which will enable us to move faster toward the goal of improving forecasters' tools.

Meanwhile, the Environmental Emergency Response Division continued to innovate. Our cover page illustrates the group's new capabilities. And we have a World First to tell you about: the objective analysis of surface ozone. As well, we can now perform simulations using the AURAMS model, with a view toward policy development. On the international stage, one of the articles in this issue discusses our contribution to monitoring observance of the Comprehensive Nuclear Test-Ban Treaty. Surprising as it may seem, the meteorological community and the CMC are very active in this area.

A new international initiative came into being in 2003: the Group for Earth Observations—a ray of hope for our planet. While it is still too early to boast, we are confident that this initiative will in the years to come help make our Earth a better place to live. You will no doubt hear more about this initiative over the next few months. And this is yet another area where the CMC is very active.

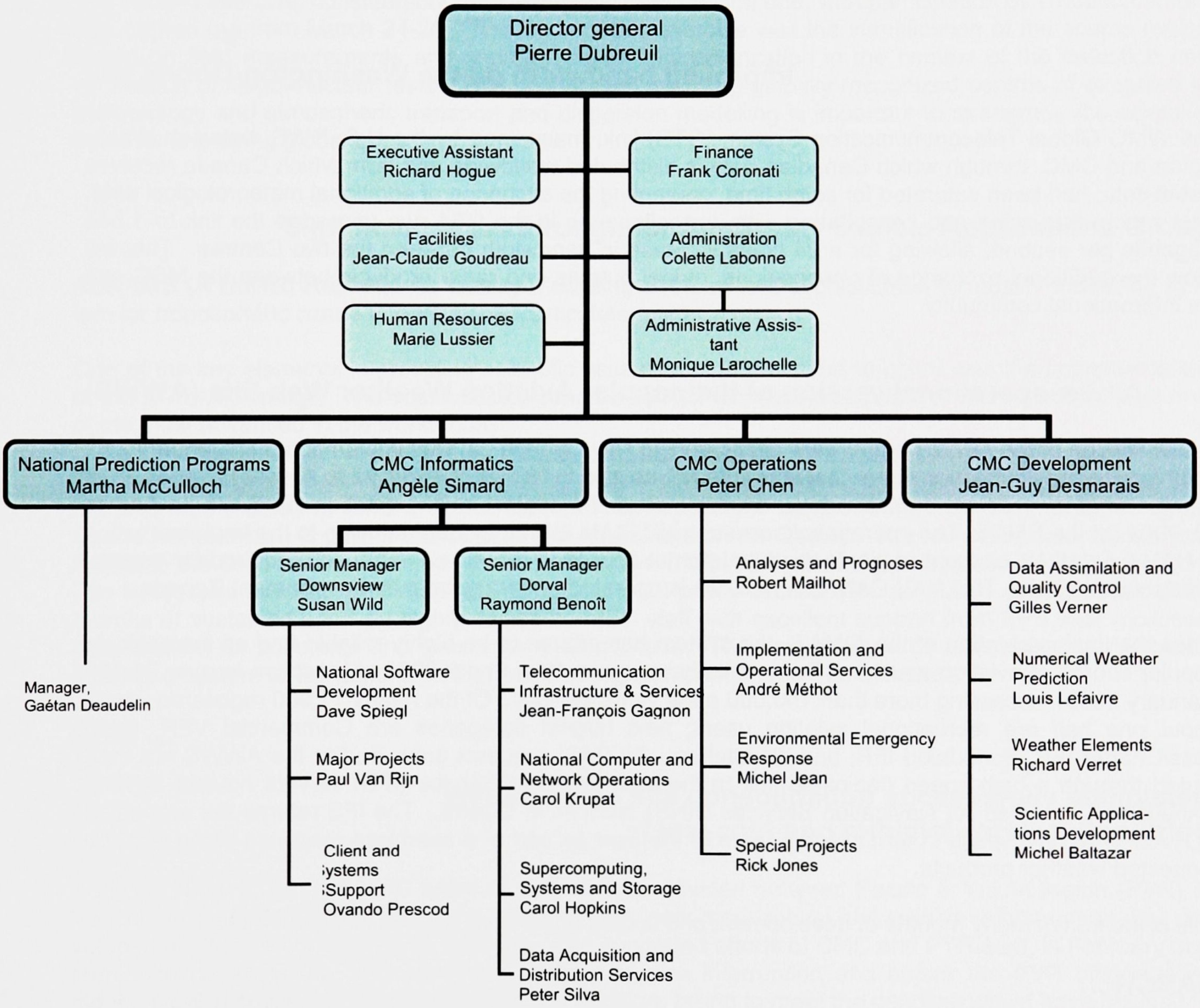
Unfortunately, so much of our time was taken up with the computer changeover that we had to put a number of service enhancements on the back burner. But don't worry—they've only been postponed, not forgotten. Our basic research is continuing and we have many ideas for improving numerical forecasting on the drawing board, so we have great confidence as we begin 2004, which promises to be a year of feverish activity.

I want to take this opportunity to thank all our employees, whose expertise and sense of duty allow the CMC to deliver quality services and programs. Happy reading!

Pierre Dubreuil

Organisation

This organization chart represents the organizational structure of the Atmospheric Environmental Prediction Directorate-General in the fall of 2002. Of the 245 employees of the Directorate-General, 200 work in the CMC building in Dorval, while others work under Informatics Branch in Downsview. It is important to note that the CMC building at Dorval also houses several groups under the Meteorological Research Branch (MRB). Exchanges between CMC and groups related to numerical weather prediction research, air quality or data assimilation and satellite meteorology, are numerous, and constitute a very positive contribution to the whole of the program.



Highlights

... As if you were there

January ...

A more robust, scalable Weatheroffice web site

The Weatheroffice web site is one of the most popular in Canada, and has become the (MSC's) principal means of disseminating weather information and warnings in real-time. In early January, we implemented a new architecture that provides a more robust, scalable and flexible base to implement web technologies. It allows for better traffic management and has added redundancy in case of failure. A second component will be implemented later this year.

Improved bandwidth on the Washington-Dorval link

The WMO Global Telecommunication System (GTS) link, maintained by the U.S. NWS, between Washington and CMC, through which Canadian data is distributed worldwide and from which Canada receives global data, had been saturated for some time, preventing the exchange of additional meteorological data. After much discussion and consultation with our colleagues in the USA, we upgraded the link to 1.544 Megabits per second, allowing for a 24 times increase in bandwidth between the two Centres. This will allow the additional exchange of observations, model outputs and radar products between the MSC and the international community.

A new operational version of the popular Aviation Weather Web Site (AWWS)

A new version of the AWWS (http://www.flightplanning.Nav Canada.ca) was implemented on January 21st. This version allows aviation users real-time Internet access to NOTAMs (Notices to Airmen) in addition to aviation weather products that have been available since the original implementation of AWWS on August 30, 2001 (at the CMC). The operational access to NOTAMs is an important addition to the implementation of NAV CANADA's concept of single window Internet access to real-time information required for general aviation operations. This NAV CANADA web site is operated under contract by Environment Canada.

Since the implementation of the AWWS, the system has proven to be highly reliable and an increasingly popular source of aviation weather. Daily visits have grown from under 8000 at inception to over 21,000 (January 2003), accessing more than 150,000 page views per day. Of the nearly 11,000 registered users, about one half are recreational aviation users; next largest categories are Commercial VFR, Business/Charter IFR, Scheduled IFR, and dispatchers. NOTAM requests submitted to the AWWS are then routed through a high speed dedicated link to the Internet Flight Service (IFS) servers housed at NAV CANADA's Combined Air Navigation Services (ANS) facilities in Ottawa. The IFS returns the requested NOTAM to AWWS which in turn delivers them to the user as part of a seamless response along with the requested weather products.

This is the fruit of many months of development and testing under contract with NAV CANADA.

MARCH ...

Bandwidth of Weatheroffice increased

The bandwidth capacity was increased in early March to meet the continuing growth of demand on Weatheroffice. The CMC had two internet connections totalling 20 Megabits per second (Mb/s). One of these lines was increased during the first week of March to 100 Mb/s. By the end of April 2003, a new contract will ensure a capacity of 100 Mb/s for each of the internet connections. Each connection will be provided by a different supplier. This will ensure both redundancy and sufficient capacity to meet the increasing demands.

Participation in the second Global Modelling Experiment

The CMC, as part of the Canadian National Authority and Delegation to the Comprehensive Nuclear-Test-Ban Treaty (CTBT), has played a major role in facilitating an agreement for cooperation between the WMO and the CTBTO. As part of this agreement for cooperation, a first global modelling experiment involving the WMO Regional Specialized Meteorological Centres (RSMC) for transport and dispersion modelling and the International Data Centre of the CTBTO was successfully carried out in May 2000.

The second exercise, considerably more extensive than the first one, with participation by a dozen centres was carried out from March 24-26. The focus of this exercise was the identification of the source region based on field measurements and source-receptor characterization in the context of the detection and verification of illegal nuclear tests. This cooperation involving globally recognized centres of expertise in meteorology and atmospheric transport and dispersion modelling is important to strengthen the scientific basis for improving global security.

Significant breakthrough for Air Quality Models Applications Group

AURAMS (A Unified Regional Air Quality Modelling System) is a sophisticated air quality modelling system for tropospheric ozone and inhalable particulate matter.

One of the key elements in providing scientific assessment and support to policy was the implementation of the AURAMS model. The sophisticated scheme used to simulate particulate matter in AURAMS is one of the most advanced in the world today.

The development of AURAMS was initiated by AQRB in 1997 and involved many research scientists. The AQMAG was created at CMC in September 2001 to support the department's commitment regarding the Ozone Annex which is part of the Canada-US Agreement on Air Quality. The technological transfer from AQRB to the CMC environment has been done by the CMC AQMAG in close collaboration with research. The successful executions of AURAMS for Canada-US policy decisions on air quality are the result of 16 months of sustained effort by highly dedicated MSC staff with excellent support from EPS staff (pollution data branch) for pollutants and emissions related issues. The next step will be to transfer the AURAMS modelling system to EC regions so that work on regional domains can be initiated.

April ...

Weather web site consolidation successfully completed at low cost and minimal service disruption

Software used to run the MSC weather web site was divided between Pacific & Yukon region (PYR) in Vancouver and CMC in Dorval. Over the past year, new more robust and reliable infrastructure was developed at CMC to consolidate all software. The concerted efforts of CMC and PYR staff, in February and March, to complete the software move, without service interruption and before the PYR office facility move, avoided costs on the order of $150K. In addition, failing to meet the deadline would have resulted in a significant service interruption, from a minimum of 8 hours up to weeks.

Strategic alliance between CMC and the National Research Council of Canada

The AQMAG of the CMC and the Institute for Chemical Process and Environmental Technology (ICPET) of the National Research Council of Canada have signed a cooperation agreement for the next two years. The collaborative project, titled "Toward a Transparent Use of Canadian and US Air Quality Modelling Tools", has the ambitious objective to develop numerical tools that would allow the AQMAG to enhance, integrate, compare and assess Canadian and U.S. air quality modelling systems. It is envisaged that in two years the Canadian air quality modelling system will be able to use processed emissions inventories generated by a U.S. system, and the U.S. air quality modelling system will be able to use meteorological fields generated by the Canadian GEM modelling system. This will provide valuable insight for many applications including, for example, those that support policy development at the Environmental Protection Services Transboundary Air Issues Branch.

This cooperation agreement builds on an exchange of letters stating intent for formal collaboration between the Meteorological Service of Canada (ACSD/CMC) and the National Research Council of Canada that was signed in September 2002. The SMC is recognized as a key player and partner for emergency response in counter-terrorism (CRTI).

On April 23, Solicitor General Wayne Easter announced the selection of 17 research and technology projects to receive a total of $28.8 million in funding under the federal CRTI (Chemical, Biological, Radiological and Nuclear (CBRN) Research and Technology Initiative) program for its second year. MSC is the lead for one of the successful project proposals and is an important collaborating partner in two other projects.

These are:

- Advanced Emergency Response System for CBRN Hazard Prediction and Assessment for the Urban Environment to accurately predict the dispersion of CBRN materials (MSC lead).
- Real-Time Determination of Area of Influence of CBRN Releases to forecast the timing, location and amounts of CBRN material deposited on the ground from an airborne plume (AECL Chalk River Laboratory lead).
- Risk Analysis, Preparedness and Management of Bioterrorism of Animal and Zoonetic Disease to determine strategies for the control and eradication of bioterrorism vectors in animal population (Canadian Food Inspection Agency lead).

May ...

Joint meeting between the MSC and NOAA's National Weather Service on Ensemble Prediction Systems

A joint meeting between representatives of NOAA's NWS and of the MSC AEPD/ACSD took place in Dorval on May 1-2. The purpose of the meeting was to identify areas of potential collaboration between Canada and US in research and development, products and services so as to accelerate and harmonize efforts and products in both countries in the area of Ensemble Prediction Systems (EPS). This cooperation will lead to common R&D activities that will result in better products for the large variety of users of EPS systems both in Canada and US.

June

Research Network and Partnerships

CA*Net 4 is primarily a research network made available to researchers at universities and government labs engaged in research and application development relating to high-performance networks. CA*Net 4, now available at the CMC, provides a bandwidth of 1 Gigabit per second. For comparison purposes ECONET, the EC network, is of the order of a few Mbits per second except at a few sites where it can reach 40-100 Mbits per second.

It is essential to have available a large bandwidth to provide efficient access to large database and super-computing power to dozens of universities and research labs, to improve our scientific understanding, to apply this knowledge to the development of Canadian policies and to improve services to the public. This is a major step towards improving partnerships with universities and research labs.

July ...

Objective analysis of surface ozone implemented at the CMC: A world first

On Monday, July 4, the AQMAG of the CMC, in close cooperation with AQRB, implemented an experimental real-time objective analysis of surface ozone over Canada and the contiguous United States. Econet users can consult the map at: http://iweb.cmc.ec.gc.ca/~afsgmof/CTM/CTMframe.html. This implementation constitutes the first step toward building a data assimilation scheme for chemical constituents.

The objective analysis of surface ozone over Canada and the United States combines CHRONOS model output with ozone observations from AIRNOW, which is managed by the U.S. Environmental Protection Agency (EPA). Environment Canada and Provincial authorities are providing their ozone observations to the U.S. EPA under the co-ordination of the New England Governors and Eastern Canadian Premiers (NEGECP).

The analysis map is available every hour, with an approximate one hour delay, from 06 UTC to 24 UTC. This new analysis system allows us to extract more information on the current state of the chemical composition of the atmosphere from current data sets.

Improvements to Numerical Weather Prediction (NWP) System

On Thursday, June 19, the CMC implemented significant changes to the Canadian Numerical Weather Prediction and Analysis System. An additional data set known as "AMSU-B radiance" from the NOAA series of polar orbiting satellites, and additional infrared radiance (IR) data from one of NOAA's geostationary satellites began to be incorporated in the analyses.

These data are sensitive to temperature and moisture. This implementation is resulting in significant improvements in the depictions of the current state of the atmosphere's moisture, particularly over oceans, and in modest improvements to the numerical model forecasts. This is the result of an extended period of collaborative work between the Meteorological Research Branch (MRB) and CMC, demonstrating technology transfer from research and development into production.

Participation at the US National Weather Service (NWS) Corporate Board Meeting

On August 26, Pierre Dubreuil represented the MSC at the US NWS Corporate Board Meeting, and gave an invited talk describing the future of meteorological services within Canada. This led to a very stimulating discussion on the future of meteorological services in North America and elsewhere. The following day, Mr. Dubreuil was invited to visit NCEP (National Center for Environmental Prediction), the U.S. equivalent of the CMC. Many areas of current and possible future collaborations were discussed, like the joint work to improve longer range forecasts by exchanging models from our respective ensemble prediction systems and exchanging product development approaches, to ensure that citizens on both sides of the border would get similar products and services.

September ...

Comprehensive Nuclear-Test-Ban Treaty (CTBT)

The first week of September saw several events related to this important Treaty hosted by the CTBTO in Vienna. These included the

- Third Conference on Facilitating the Entry into Force of the CTBT,
- 21st Session of the (technical) Working Group B
- Experts meeting (invited) on "Civil and Scientific Applications of Treaty Verification Technologies".

The Canadian Delegation to the Entry into Force (EiF) Conference was headed by the Parliamentary Secretary to the Minister of DFAIT, Ms Aileen Carroll (M.P.), and included membership from key technical departments (Health, Natural Resources and Environment). Mr. Peter Chen, CMC Director of the Operations Branch, represented Environment Canada.

Canada ratified the Treaty in 1998 and has contributed significantly to both the Treaty's technical implementation as well as political support to an early entry-into-force. At the 21st Working Group B, Mr. Chen represented the World Meteorological Organization (WMO) in his capacity as the Chairperson for the Commission for Basic Systems (CBS) Co-ordination Group on Emergency Response Activities. The CMC actively participates in this Working group, whose activities are co-ordinated on behalf of the CTBTO by Michel Jean (CMC).

In parallel with the Working Group B sessions, the second in a series of Expert Meetings was held in nearby Sopron (Hungary).

Hurricane Isabel creates high demand for MSC web sites

The highest Internet demand for MSC weather information was witnessed September 19 with the passage of the remnants of Isabel. This necessitated a number of short notice changes including the publishing of a banner on "Weatheroffice" to direct web visitors to hurricane info, the creation of web content and increasing our technical capacity.

During the week of September 14, web traffic to the Canadian Hurricane Centre web site recorded 461,000 visitors, with more than 100,000 visits (normal traffic is 18,000) on Thursday, September 18. During the same period, the "weatheroffice" web site recorded 764,408 visitors, with more than 400,000 visits (normal traffic is 280,000) on Friday, September 19.

The biggest challenge was technical – maintaining servers and providing capacity to meet the high demand. To assist with the excessive Internet demand on Atlantic Region's web server for hurricane content, the Atmospheric Environment Prediction Directorate re-configured their servers (using proxy caching) to create extra capacity. This service change was put on-line at 16:00 EDT Thursday, September 18 instantaneously increasing the capacity to deliver information to tens of thousands of interested Canadians.

This demand resulted in record bandwidth consumption for "Weatheroffice" - over 45 Mbits/second of information being requested from the servers, as compared to typical values of 12 to 14 Mbits in the summer season.

MSC organizes and co-chairs an international workshop to discuss monitoring of radioactive

A workshop of international experts to discuss monitoring of radioactive gases and the meteorological support to Treaty verification under the Comprehensive (nuclear) Test Ban Treaty was held in Ottawa on September 29 - October 2. The workshop, entitled **'International Workshop on Atmospheric Radioxenon Measurements**', was organized and co-chaired by Dr. Kurt Ungar from Health Canada's Radiation Protection Bureau and Michel Jean of MSC's Canadian Meteorological Centre. Fifty experts from nine countries attended.

The monitoring of radioactive noble gases (mainly the xenons) is one of the components of the International Monitoring System (IMS) of the CTBTO. Canada currently operates an experimental monitoring site located at the Radiation Protection Bureau facility in Ottawa and an operational site in Yellowknife.

Another operational monitoring station will be installed in late 2004 in St-John's as Canada's commitment to the Treaty's implementation. In addition to monitoring activities, complex numerical models that simulate atmospheric transport and dispersion are a critical component of the verification system in that they are one of the means to link and identify the illegal detonation of a nuclear weapon (in the atmosphere, underground or underwater) with detection at one of the CTBTO-IMS monitoring sites. These specialized models are part of the numerical weather and environmental prediction system of the MSC.

Under the leadership of the Department of Foreign Affairs and International Trade, the CMC has been involved with Health Canada in establishing the Canadian position with respect to the design of a global radionuclide network for Treaty Verification.

In addition, the CMC, with its operational global atmospheric transport modelling capability currently based on the CANERM, contributes to Canada's national technical means in support of operational decision making and technical assessments in relation to Canada's commitments under the Treaty. This global atmospheric transport modelling capability, which is integrated with the NWP system at the CMC, has earned international recognition for EC in the technical community of the Treaty Verification through its significant and on-going contribution to the design and implementation of the Global Radionuclide Monitoring Network and the development of a meteorological infrastructure within the CTBTO.

WMO/ICAO Third Volcanic Ash Workshop

This jointly sponsored international workshop was hosted by Météo-France at Toulouse, September 29 - October 3. The main purpose of the Workshop was to exchange and to consider the evolving science and technologies that could fill operational gaps of the International Airways Volcanic Watch (IAVW) programme. Participants included representatives of all Volcanic Ash Advisory Centres (VAAC) and other stakeholders: geophysicists (vulcanology), airlines (IATA), atmospheric research scientists as well as representatives of WMO and ICAO. The Canadian Meteorological Centre (known as "Montréal VAAC") was represented by Peter Chen and René Servranckx.

Airborne ash, a highly abrasive substance, is an immediate hazard to aircraft in flight, represents serious potential economic loss for carriers, both in terms of aircraft maintenance and repairs, and added fuel costs for route diversions. Such situations can be quite prolonged, as eruptive activity can persist continuously for days, or intermittently for months.

The real-time application of meteorological systems such as global numerical weather prediction and atmospheric transport and dispersion models, and satellite based multi-channel detection algorithms for airborne ash and SO_2, are critical parts of the safety measures implemented at the VAACs. Montréal VAAC presented six papers, and participated very actively throughout the Workshop. Three papers dealt with case studies (volcanic ash, airborne Asian Dust and high level transport of smoke from forest fires), one paper on the expectations for numerical simulation techniques for tracking volcanic ash, and one on the current status of the Montréal VAAC operational capabilities. The last paper provided an update on the implementation of a global infrasonic monitoring network of the Comprehensive Nuclear-Test-Ban Treaty (this network is part of the International Monitoring System for the Verification of the Treaty), and its possible application for real-time detection and location of volcanic eruptions.

The conversion to the new IBM supercomputer

On Christmas day, nearly 4 years after the project had begun, the Supercomputer Replacement Project officially ended upon acceptance of the IBM system after the completion of its 30-day availability test. This test was the final required milestone to initiate the contract. The IBM contract is for 5 years with a 2 1/2 year optional extension which includes an upgrade mid-way through the contract and again if we elect to exercise the option to extend the contract.

The IBM system is comprised of 936 processors, 2.12 TB of memory, 15 TB of high performance disk storage and a high performance switch; overall, it is 2.5 times more powerful than the previously installed NEC SX-6 while the upgrade will provide 6 times the power of the SX-6.

PROCUREMENT

Close to 50 MSC FTE's were consumed in the overall project. It began in the spring of 2000 with the establishment of User Requirements. A team formed of representatives from various user groups established a baseline for the supercomputer requirements for a system to be installed 3 years later and valid for the life of a contract; hence plans had to be established for the next decade. This resulted in a document presented to and approved by the Project Review Committee which was then used by the technical team to determine MSC's computing requirements.

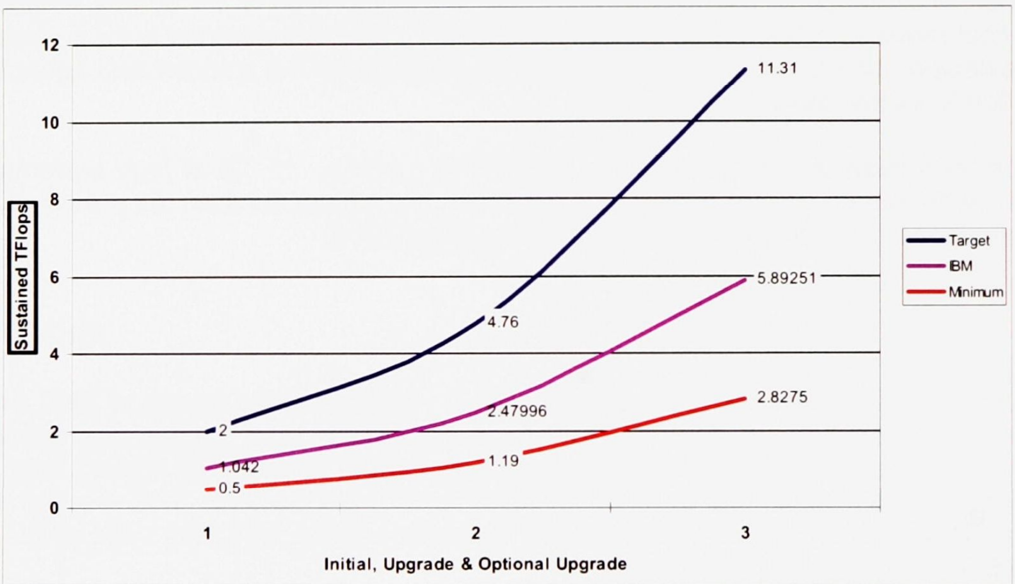
Upon completion of this phase, the technical team went on a technology tour and visited the likely bidders. Armed with user requirements and vendor plans, MSC proceeded with the next phases of the project. A Request for Proposal (RFP), which included a detailed contractual component, technical specifications including conversion requirements, benchmarks & benchmark rules, infrastructure specification, as well as professional services, was prepared, jointly with PWGSC.

The specifications varied from previous supercomputer RFPs in a number of ways. Firstly, regulations within PWGSC had changed since the last supercomputer procurement, and although the "lowest bidder" was attractive to us, there was the very real possibility of vendors bidding higher than our budget. In the past, the rules allowed negotiation with the lowest bidder to bring the project within budget. This was no longer allowed and could be devastating to MSC's programs should it arise, as the entire process would need to be re-started. As such, we divulged the budget in the RFP, and vendors needed to bid to a power curve. The entire RFP was built around this power curve. Vendors would then choose the performance level and from this curve the CPU power, memory, & I/O were derived.

The graph next page shows the power curve. The lower curve was our minimum requirement. Any vendor bidding below this curve would be considered non-compliant. The “target” reflected computer power corresponding to user requirements, which we expected to be beyond our financial envelope. Vendors were free to choose their performance level within specified guidelines. IBM bid the center curve.

Issues related to the infrastructure were a challenge to the technical team for quite some time. Scalar systems are inexpensive compared to vector systems but have many hidden costs. Chief among these are a much higher footprint, and much higher electrical costs. These were significant concerns because some of the potential bidders' systems did not fit in the machine room. Our initial specifications and pre-release included charging a high premium for square footage above our available space. Fortunately, MSC was able to obtain larger computing facilities, which removed this as a factor. As well, the vendors bid included electrical costs.

Adding time to the process, though highly beneficial, was an industry review of the pre-released technical specifications. This review was useful to provide us with feedback on vendor issues and helped ensure that we were on a path where multiple vendors could bid. PWGSC chaired these meetings to ensure impartiality. It was also useful for us as a team to ensure that PWGSC understood many of the sensitive issues. A side benefit of the pre-release was to provide vendors with an early version of the specifications and benchmarks. Although these were subject to change, this gave vendors a heads up and a chance to begin work, thereby minimizing the length of time the final RFP was out.



To reflect the times we live in, where reliance upon automated products and timely delivery is key, we were also much more aggressive with the required response time. During office hours, the vendor must respond and be on-site within 30 minutes of being called, while outside business hours, one hour is allowed. At the same time, we also reduced the Preventive Maintenance schedule allowed in any given month, so as to maximize availability to the user community.

A critical part of the RFP was the benchmarks. These would be used to determine if a vendor was meeting the performance criteria for the contract win, to initial the contract, and for each upgrade. Some tests were to validate processor performance, node performance, switch performance and system scalability, while others validated requirements from the technical specifications, such as network performance, single node I/O performance, and multi-node I/O performance. Failure of any test is considered failure. The rules also specified that if any test failed, the entire suite of tests needed to be restarted from the beginning, including a system reboot.

Our RFP was released on 22 March 2002 and closed on 22 June. This marked the start of a technical evaluation, followed by a financial evaluation. A month later both evaluations were completed, with all bidders determined as compliant. Using the point system defined in the RFP, the bidders were ranked where 90% of the score was awarded for performance and 10% for price. At this point, IBM had the highest score.

In early September, the technical team along with PWGSC witnessed the Pre-Award Benchmark (PAB). Because of the size of the system required, the team felt it was unreasonable for a vendor to make available a full sized system. As a result, the Pre-Award Benchmark required tests be passed on 25% of the system proposed. The twelve hour PAB included a subset of the types of code run on the supercomputer. Upon successful completion, the contract was then signed and awarded to IBM on 12 November 2002.

Once the contract was signed and because of the tight schedule ahead of us, we obtained early access to the IBM system at NCAR while we awaited delivery of our conversion system. This allowed porting of key libraries essential for the conversion to proceed.

SYSTEM INSTALLATION, TRAINING & CONVERSION

As per the contract requirement, a small conversion system, roughly 10% the size of the initial system was delivered in December 2002 to allow the conversion efforts to begin while planning for the main system proceeded.

The physical installation planning process was a challenge in itself. The heat generated by the systems required careful layout to ensure the systems do not overheat the neighbouring frames. An IBM specialist was hired for this task to ensure that layout & tile cut-outs maximized the air flow, thereby ensuring proper cooling of the system. As a point of interest the floor space requirements are 100 square metres, the cooling requirements 67 tons (235 kWh) and power requirements 275 kilowatts.

Once the infrastructure was ready with proper tiles and electrical preparatory work completed, we were ready to receive the system. On 3 March 2003, five 11 metre vans started delivering the system. A team of 25 IBM SP specialists worked around the clock to install the 28 frames, SP switch, storage, and many miles of cables that make up the system. Eight days later, the system was physically installed and powered up.

The physical installation was a simple step on the road to acceptance. There remained multiple training sessions for developers, system & network administrators, and operators to set up in Montreal, Downsview and Victoria, system & network installation, tuning, performance & functionality testing as well as conversion.

It took over one month to do a base software install by the IBM experts. Still, after one month this "standard" installation did not include many of the packages required by a supercomputer, nor would it meet any of the performance criteria. This is a complex system running a batch subsystem, a global file system and many other (HPC) particularities. A number of IBM experts were made available from the U.S to deal with the day-to-day issues and activities: some were benchmarkers with tuning experience, while others dealt strictly with specific system tools and packages. In addition, IBM provided an on-site system administrator from the U.S. for several months to help with configuration issues and the functionality testing.

AEPD-DG, Pierre Dubreuil powers on an IBM frame

The process of installing, configuring, tuning and meeting the RFP functionality & performance requirements took a little over 8 months with a team from MSC and IBM working closely together. While this was on-going, conversion of applications was proceeding.

Conversion was divided into 3 priority levels. Both Priority 1 & Priority 2 activities needed to be completed prior to the 30 day availability test. IBM provided resources to help us achieve the stated goals as rapidly as possible. A help desk consultant was made available between the hours 7 AM to 7 PM, from February until system acceptance, to provide rapid responses to the user community. A system software analyst was provided to help with Priority 1 activities. Four application experts (three of them working remotely from the U.K. and one from the U.S.) with many years of experience in optimizing codes provided the required expertise to assist in the conversion of our operational codes. Oftentimes, additional expertise was required to help with more complex issues.

Priority 1 activities related to the porting of system and network tools. This included a number of home grown applications such as monitoring tools for operators, as well as public domain packages. In the case of the operator monitoring tools, most of the effort was in teaching the application the IBM messages. Many scripts needed to be re-written to adapt to the AIX operating system and to the functioning of the cluster. Accounting reports and statistics gathering needed to be re-done. The packages needed re-thinking to deal with the many nodes. As well, guides for operators and analysts needed to be developed. Along with the IBM resource many Informatics Branch staff was involved in this activity.

Priority 2 activities related to the conversion of all operational supercomputer applications needed for both the CMC operational runs and Climate Policy runs. For all of these, the code and scripts (assimilation systems, NWP models, Climate models, Air Quality models, Wave models, dispersion models, etc.) running on the NEC were modified in order to run effectively on the new IBM's. In all, millions of lines of code and a few thousand scripts had to be reviewed and modified. Results from each of the components running on both the NEC and the IBM were compared and validated to ensure that the conversion process did not result in the introduction of bugs (a number of which were introduced but fixed thereafter). Several algorithms had to be modified and optimized in order to run as efficiently as possible on the IBM.

In particular for the CMC production runs, the validation required running assimilation systems and prediction models on a significant set of development cases (a 4-month period for the global system, for example) and comparing the results obtained on the NEC and on the IBM's to ensure that meteorological results produced from both systems are the same (though not necessarily identical). This validation process requires an examination of results by meteorologists as well as a complete set of verification measures comparing the performance of the application running on the NEC and the IBM. Obviously, the validation process had to be redone for those applications in which bugs were discovered and fixed. Some of them were quite difficult to investigate, and required the combined expertise of MSC and IBM experts to develop and implement the fix. The validation process is tedious, but essential to ensuring the integrity of applications running operationally on the IBM.

Following the code validation, all the applications were installed in parallel in the operational environment for the final phase of applications acceptance, i.e. the end-to-end testing. In that mode, the performance of the operational suites running in parallel on the IBM's and NEC's was continuously monitored and assessed to ensure full integrity of the new system. This assessment is virtually identical to the one done at CMC prior to any implementation in the operational runs. For the end to end testing, it required that a standard set of comparative performance measurements between the IBM and the NEC runs be put in place. In addition, the outputs of the runs produced on both systems were thoroughly assessed by CMC operational meteorologists as part of the final acceptance process.

Priority 3 activities related to non-operational codes were comprised of R&D applications. While none of these were contingent upon the acceptance of the IBM, there was a lot of pressure on users, since the NEC supercomputer would be removed within weeks of the IBM's acceptance.

CONCLUSION

A supercomputer change of this nature is a major task. However, it is a necessary step to ensure that the national centre has the supercomputer infrastructure to improve the NWP systems that are the cornerstone of the services provided to all Canadians.

During the conversion period, which took close to a year, very few changes were introduced in the CMC operational production. On a short term perspective, CMC resources dedicated to this conversion activity cannot focus at the same time on transferring new science into operational runs. However, while the conversion of applications was going on, research activities aimed at improving NWP systems continued. With the implementation of the IBM, the fruits of the research done during the conversion to bring major scientific improvements to the NWP systems will be transferred to operations at an accelerated pace.

Status of computer and telecommunication systems at the end of December 2003

The CMC operates a 24/7 data centre in support of forecasting activities. The computing and telecommunications infrastructure consists of over one hundred and fifty operational systems, including a departmental wide area network with over 110 nodes. This infrastructure, as well as the many operational products which pass through it, are actively monitored around the clock by the operators and automated applications of Network Operations (NETOPS). The Network Operations Service Desk is the single point of contact for all clients, national or international, including Government of Canada and third party clients to report problems or request information on products and services. It is a critical control point for the coordination and resolution of operational problems. In February 2003, a new ticketing system was installed at the desk concluding efforts to simplify and automate our incident tracking process. In addition, a Help Desk located in Dorval operates during weekdays as user support for the supercomputer and related computing infrastructure.

Statistics on calls and service requests by the Service Desk and Help Desk in Dorval for 2003	
Service Desk and Dorval Help Desk	
Service Desk System Problem Tickets:	2 200
Service Desk System Problem Tickets:	20 800
Help Desk Tickets:	1 660
Help Desk Telephone Calls (external):	1 300
Secure ID Card Interventions:	7 725

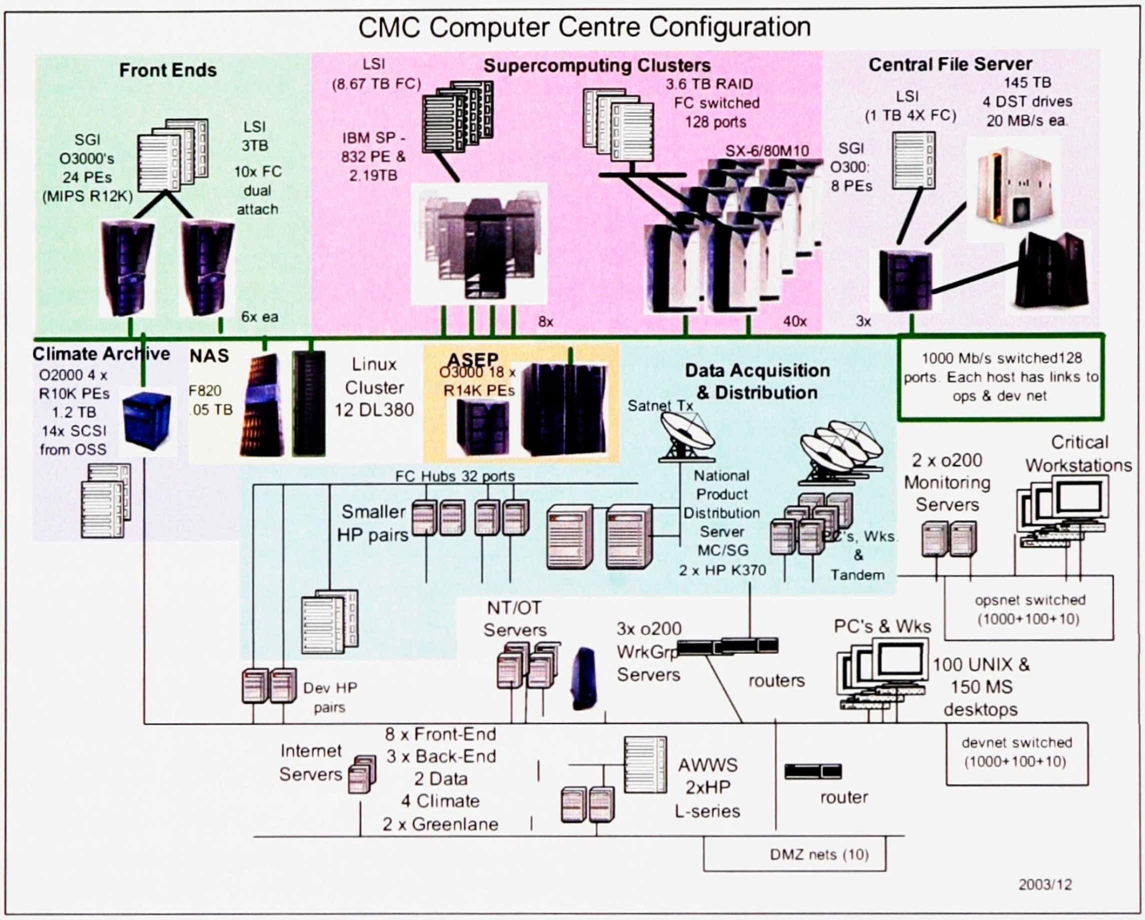
The following table provides a configuration summary of the major systems as of 31 December 2003:

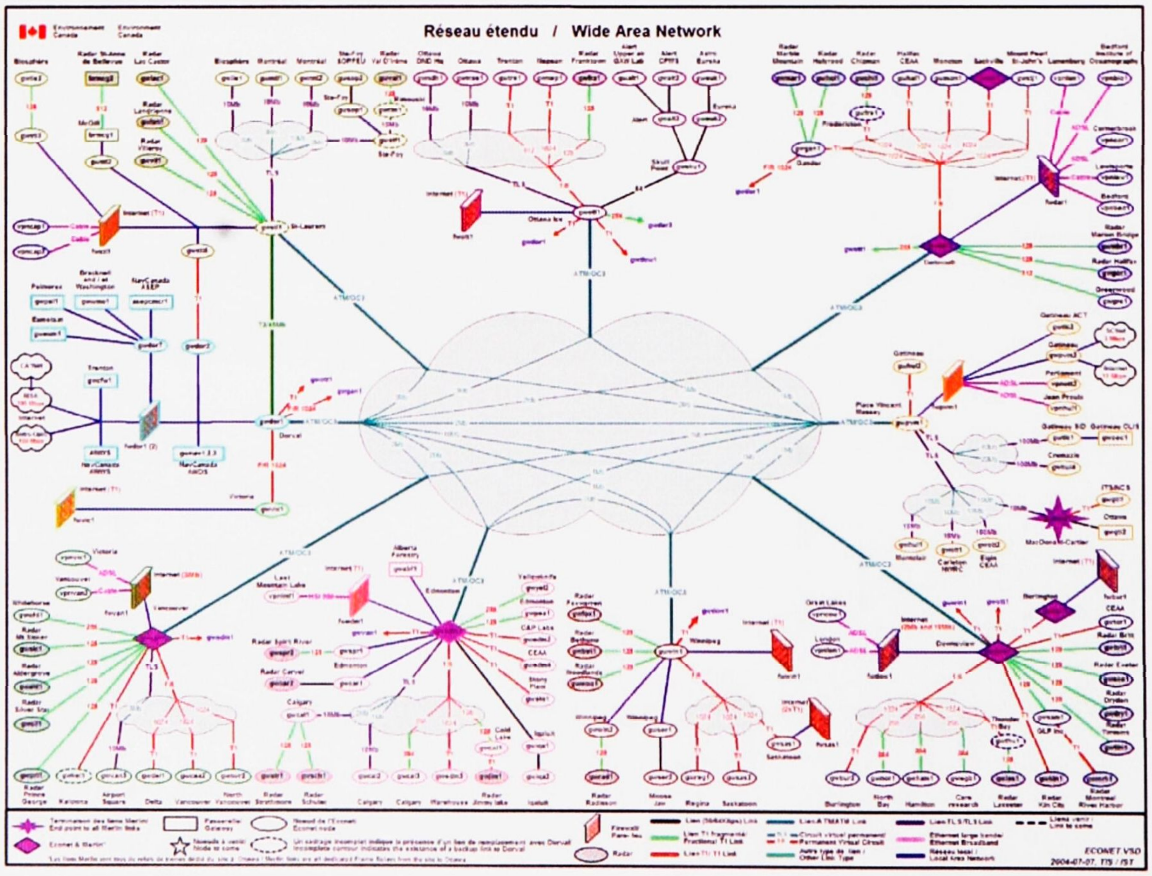
Summary of Operational Systems (December 2003)

	Computer	Processors	Memory (GB)	Disk Capacity (GB)
Supercomputer	NEC SX-6/80M10 IBM eserver Cluster 1600	80 928	640 2190	7300 15000
Front-Ends	SGI Origin 3000	12 / 12	12	4000
CFS	SGI Origin 300	8	8	1000
Canadian Climate Archive	SGI Origin 2000	4	1	1200
Data Switching	TANDEM Himalaya	4	0.128	24
Data Acquisition	2 HP K370 2 HP K260	2 each 2 each	0.512 each 0.448, 0.512	60 24

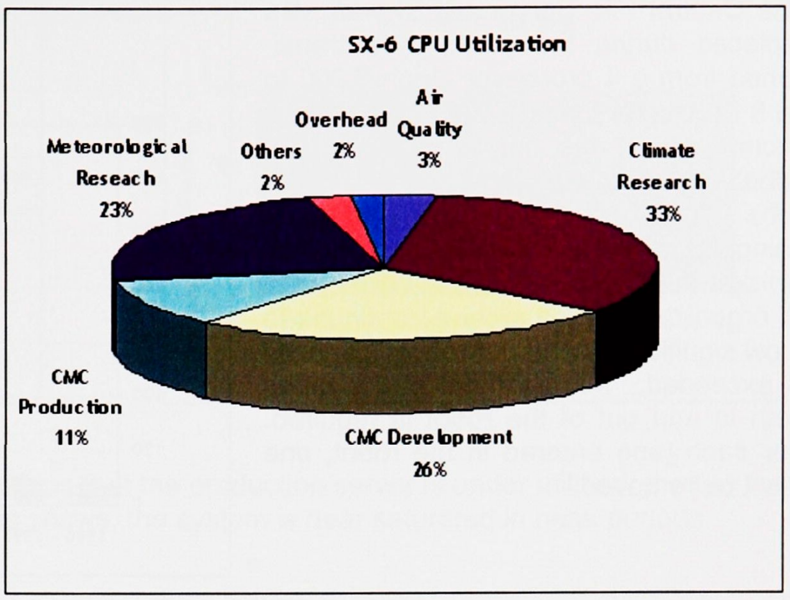
Computing Infrastructure

The following diagrams provide a simplified view of the computer infrastructure and local area network.





We had a busy year! A significant effort was placed on moving computer systems to a new computer facility, systems were upgraded and maintained and all the while the implementation of the IBM was on-going.



For many, the effort was concentrated on the conversion activities related to moving from the vector architecture of the NEC SX-6 supercomputer to the super scalar architecture of the IBM P690. Since this was the last year of the NEC contract, few changes were made to the system.

We made full use of the SX-6 through the end of the calendar year. The graphic opposite shows the relative use of the main supercomputer user groups, the largest of which is the Climate Research group

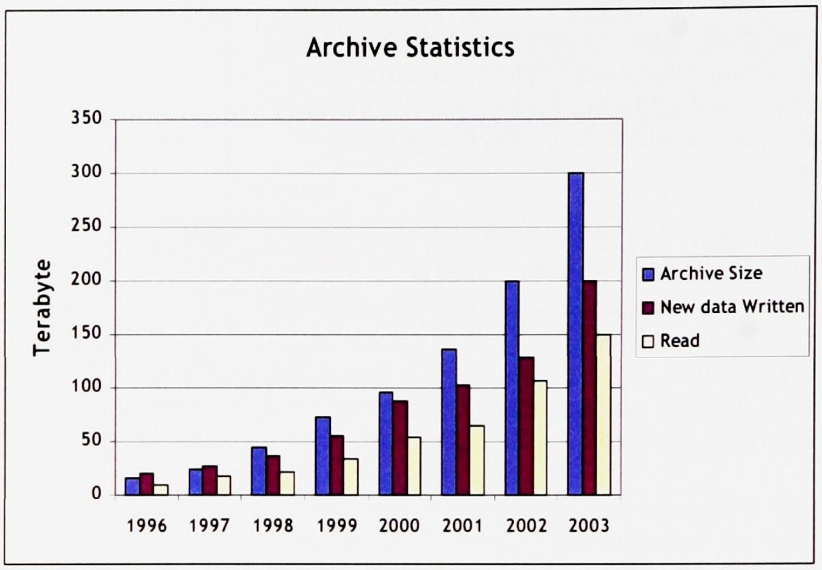
After a very busy year, the IBM was accepted on December 25th. While some users had completed the conversion, transition from parallel to operational status for those remaining was to proceed in the new year.

In January, the SGI 3000 replacing the SGI 2000 twin SGI front-end servers were accepted. All told the performance was increased 3-fold for processing power, memory availability and I/O performance, and there was a doubling in disk space. The long awaited upgrade alleviated the resource crunch felt in the past months. As we moved on the new servers, the batch queuing system in place was SGE, a change from NQS. With this, we now have one integrated batch system for the supercomputer, front-ends and linux cluster. It should be noted that a move to LoadLeveler is expected for the IBM.

Component	2002		2003 Upgrade	
	Production	R&D	Production	R&D
Processors	16 (195Mhz)	16 (195MHz)	12 (600 MHz)	12 (600 MHz)
Memory (GB)	4	4	12	12
Disks (TB)	1.5		1.4	2.4

By year end, plans were in place for upgrading our front-ends. Contract modifications, to be implemented early in the next calendar year, were made to reflect the results of the latest negotiations with SGI. An additional 8 processors and 8 GB of memory will be added as well as an additional 7 Terabytes of disk space. Plans continued with off-loading many of the graphics chart production from the production server onto our small linux cluster. By year end, generation of RADAR products, and many graphics destined for the web were produced from the cluster.

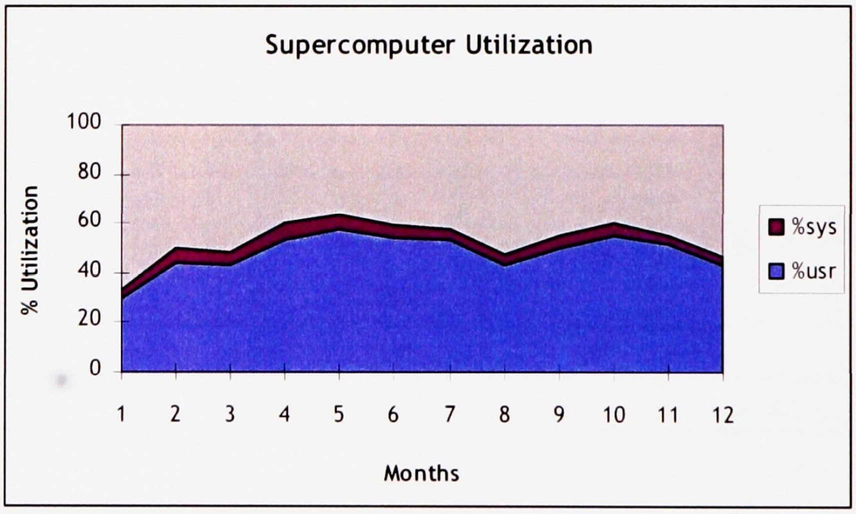
The Central File Server (CFS) was also replaced during the year. We transitioned from a 4 processor Origin 2000 to an 8 Processor Origin 3000. Last year, a second robot was put in production to handle all system backups and log collections. Testing of the tape drives was ongoing for use as an HSM (*Hierarchical storage management*). Even so, as with all organizations, the archive continues to grow significantly and our robots' capacity is exceeded. Management of the tapes both in and out of the robot is required. For each tape entered in the robot, one must be removed.



Some statistics

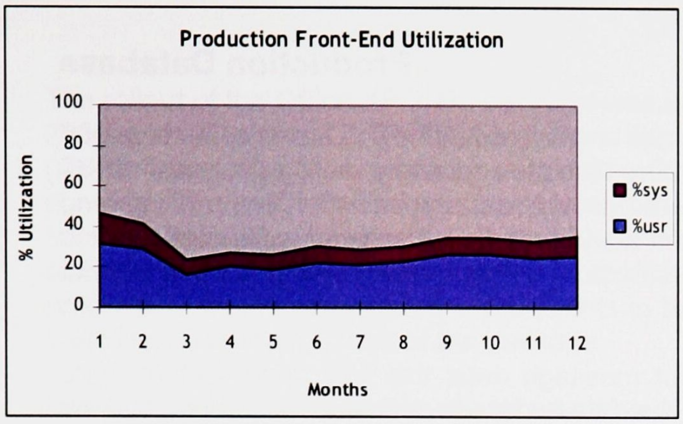
The supercomputer

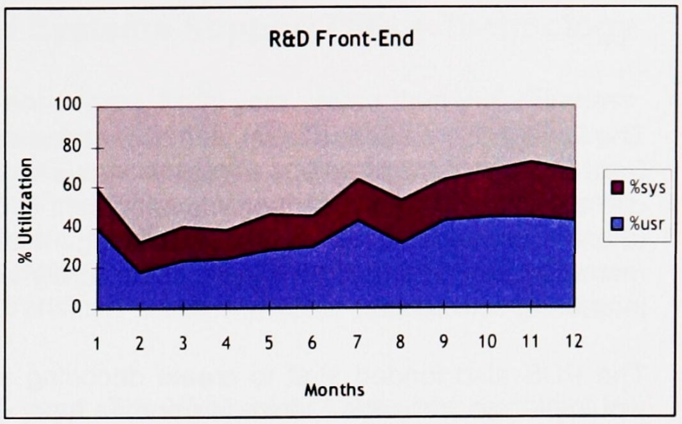
The NEC SX-6M10 operated at 60% utilization, across all 80 processors, for most of the year. In reality some of the processors were reserved for I/O, which means the system was in fact even busier.



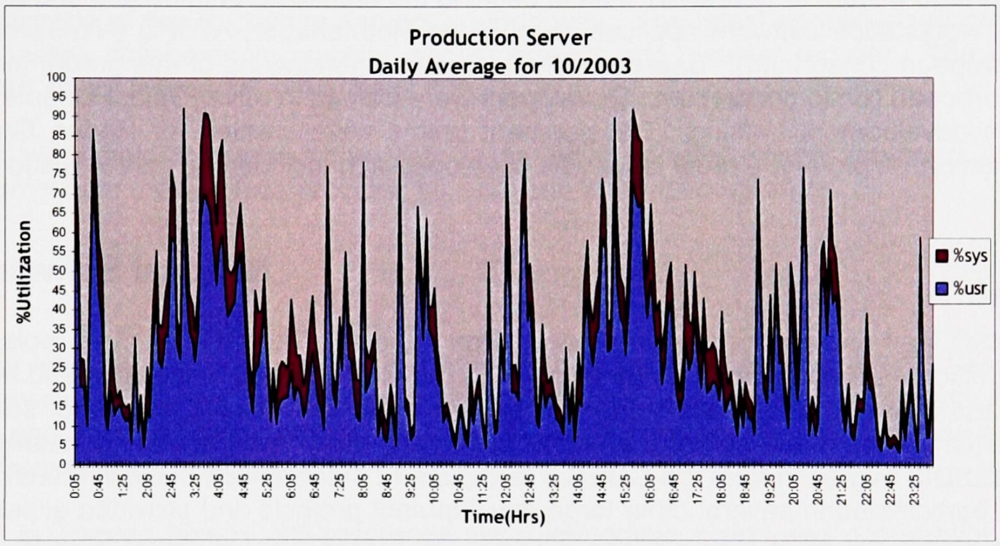
The Front-End Servers:

Load on the front-end servers dropped from January to February as the more powerful system was put in service. However, by year end, the system was as busy as prior to the upgrade. Load on the R&D server was less predictable than on the Production servers.





Though the annual results may give the impression that the production server is under utilized, the key for this system are the peaks. As the next graphic shows, the system is near saturated in peak periods.



Major Projects

Weatheroffice

The weatheroffice transition from many sites into one cohesive implementation was completed in June, 2003. A substantial amount of the site was rebuilt during the transition. The major renovations included changes to the structure of public forecasts, an update to the radar display and the creation of a comprehensive test infrastructure. SCRIBE output was also decoded and will be integrated with weatheroffice when Scribe is implemented operationally across the country.

Green Lane

The MSC Green Lane site was completely renovated to meet CLF guidelines. This effort was completed in the spring of 2003. New servers were purchased to replace the aging development systems. Efforts to address governance and change management processes were initiated.

Production Database

The Production database team was assembled in the summer and fall of 2003. The National Archive and Data Management prototype database was integrated into the IB code repository during the initial development cycle. The subsequent development cycle integrated several data types which are running 'end to end' from collection to output and testing. A development environment was created, with configuration management, automated testing and the ability to make a 'sandbox' for each developer to work in without interfering with others.

The PDB also funded staff to create decoding software for message data; this was done so that there would be one, supported, decode per data type. Plans for the data access level and the low level routines were started for the AWMSD Data Management Framework Project.

Workstation Project

Informatics lead a team of IT and MT staff in defining the architectural attributes and assessing a variety of forecaster workstation software applications such as MetManager, AWIPS (NWS), Horace (UKMet) and NinJo (European consortium). Based on the final recommendations of this group, the project decided to join the European NinJo consortium. Developers were trained in Java, Object Oriented Design and NinJo application development training. Development teams were created for Radar, Graphical Editing and Implementation. A prototype radar layer was developed and included as part of NinJo release 0.7.

National Software Development

In 2003 NSD lead and participated in several large projects. The GOES/DSAT replacement project reached a significant milestone in 2003 by completing the RFP process, assessing and evaluating the resulting bids, and installing operationally the first system in Dorval. Arrangements for seven additional processing systems were made before the end of 2003, with those systems being installed early in 2004 before the NESDIS migration from the GOES-8 to GOES-12 satellite took place in March.
NSD also participated in several other large development projects and provided expertise and assistance as requested for the NCS Replacement Project, the Production Database Project, and the Forecaster Workstation Project.

As in other years NSD continued to provide application maintenance and support services for a large list of applications under its responsibility. In 2003 porting activities were front and center, with many MSC applications requiring porting from the vendor-specific HP-UX operating system to the open-source Linux operating system. Major functionality improvements were also added to several NSD-maintained applications including Satnet and PDS. Support to Nav Canada, on a cost recovery basis, for MSC software running in Nav Canada locations continued in 2003 with higher levels of support this year than in recent years.

In 2003, as in other years, NSD continued to take a leadership role within MSC in issues related to software development standards and methodologies. NSD continued to both represent Informatics Branch and be significantly involved in the MSC Software Management Board, and was active in promoting the adoption of the newly formed Configuration Management Office. Internally within NSD a successful migration from a more expensive Clearcase software repository to a more cost effective Accurev repository was completed.

Client and Systems Support Office Technology

The rollout of the Office XP 2002 package was underway early in the fiscal year. More than 900 Windows 2000 and Windows XP workstations were upgraded from version 95/97. Client and Systems Support (CSS), Informatics Branch has since installed Office XP on 300 new desktops and laptops. Systems Management Server (SMS) tool was used to automatically install the Office package. This facilitated keeping track of the number of installs as well as ensuring a consistent installation across the client base. SMS is also being used to install other software applications, operating system (OS) service packs and software patches. Training was offered to the clients to help them transition to the new office package and to more effectively use the features of the package.

Improving the remote access model was also a focus this year. The VPN solution was heavily tested by the section and launched to at test client group in January. The VPN implementation follows the departmental standard and client workstations can connect to a subset of the intranet such as the terminal and mail services. The terminal server environment provides authenticated clients with a common platform plus the full suite of office applications and full access to the Intranet. The terminal services strategy reduces the number of software installations and applications supported on home workstations.

A department wide upgrade of the Exchange servers is underway. The latest upgrades will provide improvements in functionality, collaboration, stability, access speeds and disaster recover. The upgrades were largely successful, minor issues are being dealt with.

Information sessions were held throughout the year in an effort to keep clients informed about the changes and improvements to the services provided by CSS and Informatics Branch.

IT Services

The connection to the internet was upgraded from 2 Mbps to 5 Mbps in December 2003. Clients have noticed a great improvement in the speed of file transfers. These improvements are especially important to research projects and data gathering processes. The faster access speeds have greatly enhanced staff's ability to work from locations outside of the ECONET.

The August blackout in Toronto taxed CSS resources since immediate action and cooperation was required of all staff. The shutdown of the Ontario Weather Office and related systems was a priority since the operations were switched to another region and the servers had to be gracefully shutdown before the power supplied by the generator expired. After the threat of further blackout was gone, the servers were once again brought online and services were restored. The staff showed dedication and a significant amount of effort went into planning and handling of the crisis.

Immediately following the blackout, the Downsview building, along with many other EC locations was hit with a major computer virus outbreak. The effects of the outbreak were magnified by the fact that so many clients, whose machines were off for a week due to the blackout, returned to work on the same day once building were re-opened. CSS worked diligently to isolate and protect the segment of the network that the Weather Center operates on so that their operations were not affected. CSS is now taking greater advantage of SMS and other automated tools to ensure a more consistent desktop. Patches and virus updates are evaluated and implement on desktops in a timely manner to reduce the risks. CSS is also working with other EC groups like the National Security team to ensure a consistent approach to mitigation and crisis.

Development of Specialized Tools for Meteorological Forecasts

Over the previous year, the MSC joined an international consortium, consisting of Germany, Switzerland and Denmark, to develop new software tools for specialists in meteorological forecasting. The system, called NINJO, is being developed using Java object-oriented technology. Being an international project, it presents a certain number of challenges in terms of communication and co-ordination, but the efforts expended will be rewarded with the sharing of new functionalities. The first operational system is slated to be accessible toward the end of 2004-2005.

Group on Earth Observations (GEO) ... hope on the horizon

Johannesburg, South Africa, August 26 to September 4, 2002 ... tens of thousands of people assembled together for the World Summit on Sustainable Development, organized by the United Nations. In Evian, France, the G8 Summit was held in June 2003. At both meetings the participants expressed a common concern for taking concerted action to measure the pulse of the Earth, to learn more about it. The goal of all this activity was to better manage our good old planet, which we, "Homo Sapiens Sapiens", are so carelessly mistreating.

It was against the backdrop of those events that the United States invited a number of countries and international organizations to an Earth Observation Summit (EOS-1) in Washington from July 31 to August 2. Thirty-three participating countries, including Canada, and fifteen international organizations agreed there to pool their efforts within the Group on Earth Observations (GEO), whose objective is to establish, within ten years, "a comprehensive, coordinated, and sustained Earth observation system or systems". All countries are invited to join the original core group of participants, since the issues are global.

To attain this goal, the Summit formed five specialized subgroups whose first task will be to create an implementation plan for achieving the objective. One is the Subgroup on Data Utilization (SGDU). Pierre Dubreuil, Director General of the Atmospheric Environment Prediction Branch, agreed to be one of the international co-chairs of the SGDU; Robert Mailhot will assist him in that task The subgroups have only one year to produce a plan for setting up this earth observation system or systems. A mammoth task awaits the players in this exercise when the work begins in earnest in September.

Baveno, Italy, late November ... after many conference calls and innumerable E-mail exchanges, a coordination meeting of the whole GEO family was held (GEO-2, GEO-1 being the one in Washington). What we found was ... dedication, passion and a great deal of progress; but as expected, many questions and much work remains to be done. However, enough of a start was made for us to prepare for the GEO exercise in Canada (CGEO), and quickly. After initial discussions, the federal departments and agencies likely to be affected were called to a first working meeting to be held in late January 2004 at the Canadian Space Agency's headquarters in Longueuil. The result was a great success that augurs well for the future. But now it is 2004; more news is to come ... in the CMC 2004 Annual Review.

For more information, visit the Canadian GEO web site at http://www.cgeo-gcot.gc.ca and the international GEO web site at http://www.earthobservationsummit.gov.

The Comprehensive Nuclear-Test-Ban Treaty, "CTBT"

AKA: "What's a meteorologist like you doing in a place like this?"

Introduction

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) is intended to assist in achieving world-wide nuclear disarmament, reductions in nuclear weapons arsenals, and prevention of the proliferation of nuclear weapons, by ending all nuclear explosions through a verifiable regime. The objective: the enhancement of international peace and security. The Treaty was first open for signature by the Secretary General of the United Nations, inviting all States to sign in September 1996. Canada was among the first signatories to the treaty, which it ratified through an act of Parliament in December 1998. At the same time that the Treaty was established, the U.N. created, at Vienna, Austria, a corresponding organization called the CTBT Organization (CTBTO).

Canada supports the earliest possible Entry-into-Force of the Treaty, and since it's ratification has been contributing to the implementation of the Treaty's provisions for a Verification regime based on 4 surveillance technologies - seismic, hydro-acoustic, infrasound, radionuclide – as well as an On-site Inspection regime. The implementation of the Treaty in Canada is led by the Department of Foreign Affairs and International Trade, while the main Departments that are building the Canadian components of the verification system are: Natural Resources Canada, Health Canada, and Environment Canada.

What does Environment Canada bring to the banning of nuclear explosions? The CMC has been providing highly specialized numerical simulations of the atmosphere to track the movement of airborne radionuclides since the major crisis of the Chernobyl Nuclear Power Plant accident of 1986 in the Ukraine. With these specialized tools operationally in place, the CMC was well placed to become involved in policy support to Canada's positions related to the renewed interest in a total nuclear-test-ban in the early 1990's. In fact, one application of the operational CANadian Emergency Response Model ("CANERM") was to quantify the performance and sensitivity of different proposed global radionuclide monitoring networks. The purpose is the identification of radioactive signatures that would result from a nuclear weapons test, considering various network configurations, detection limit of the sensors, location of detonation and variations in the atmospheric circulation. The results of these simulations were presented to the international community of experts in 1995 and highly influenced the outcome of the Treaty negotiations on the specifications of the global radionuclide monitoring network.

Also worthy of note is the pioneering work of Air Quality Research Branch scientist Dr. J. Pudykiewicz, through the late 1980's and early 1990's, regarding the atmospheric transport of radioactivity and weapons testing debris. Dr. Pudykiewicz suggested the potential use of such numerical simulations to assist in locating clandestine nuclear explosive tests, a concept viewed sceptically by many at the time but which today is a nearly operational technology. The MSC has a long history in the application of advanced simulation tools in support of its policy objectives of completely banning nuclear explosions and realising nuclear disarmament, as well as demonstrating how meteorological systems benefit the Verification regime. Through cooperative work with the Radiation Protection Bureau of Health Canada, the CMC is at the forefront of the synergistic applications of sophisticated atmospheric modeling with real-time measurements of background radioactivity. This work is one of the cornerstones of research and development activities underway to bring atmospheric modeling down to the urban scale and strengthen Canada's response to terrorist attacks with chemical, biological, radiological and nuclear materials.

Highlights of 2003

In 2003, the CMC, through its specialized division in Environmental Emergency Response, continued to contribute, and in many instances lead the building and enhancement of tools and support to the CTBT Verification Regime. As well, through a variety of international collaborations with national meteorological centres and institutes, coordinated from the Provisional Technical Secretariat of the CTBTO, momentum was built to gather sufficient political support to finalize a formal landmark agreement between the World Meteorological Organization (WMO) and the CTBTO, at WMO's Congress of 2003. Collaborators are realizing the benefits of the developing technologies in numerous applications, aside from those of Treaty Verification. Mr. M. Jean continued his role as the chair of a working group in the CTBTO for cooperation with the WMO and represented Canada at the CTBT Technical Working Group "B".

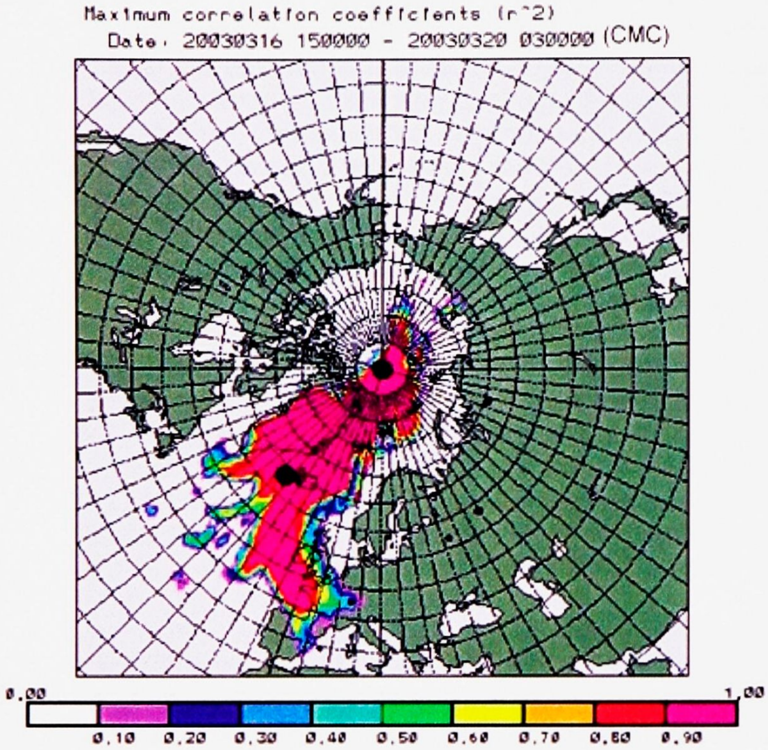
In March, Mr. P. Chen participated at the CTBTO's Introductory Course on On-site Inspection (OSI). Fresh with the experience of providing operational meteorological support to the OSI field experiment of September 2002 in Kazakhstan, this workshop was an excellent opportunity to learn and to contribute to the understanding and discussions of operational deployment of a team of inspectors and supporting elements to a suspected site of a nuclear test explosion. Not surprising, meteorological factors are important considerations in the successful operations of the OSI, and will be further discussed and tested in future experiments and the development of operational plans.

One of the technologies relates to the detection of radioactive noble gases in the atmosphere. When the Treaty was negotiated, there were no operational monitoring technologies with sufficient sensitivity to fulfill the detection limits. Existing research prototypes in Sweden, the United States, Russian Federation and France were further developed through an initiative called the International Noble Gas Experiment (INGE), in which we are currently in the third phase. To follow up on the on-going activities on the INGE, regular workshops have been organized. Canada offered to host one of those technical workshops. A workshop of international experts to discuss monitoring of radioactive gases and the meteorological support to Treaty verification under the CTBT was then held in Ottawa on September 29 - October 2 2003. The workshop titled **'International Workshop on Atmospheric Radioxenon Measurements**' was organized and co-chaired by Health Canada's Radiation Protection Bureau (Dr Kurt Ungar) and by the Canadian Meteorological Centre of Environment Canada (Mr Michel Jean). Fifty experts from 9 countries attended and important decisions with respect to the upcoming phase 4 of the INGE were taken.

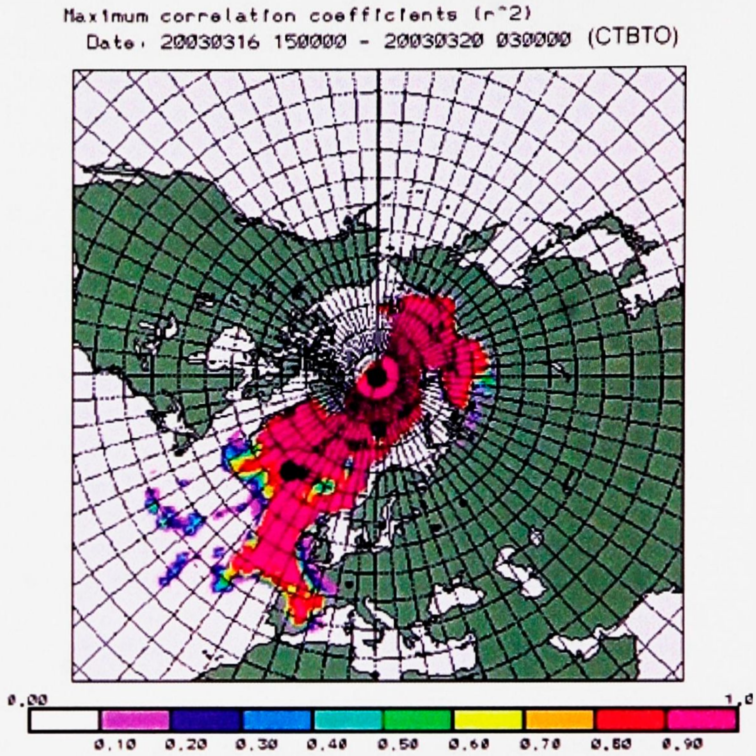
In September, Mr. Chen participated in a series of meetings both as a Canadian delegate to the Entry-into-Force Conference, and as a representative of the WMO to the CTBTO's Technical Working Group "B". As well, he participated in an extraordinary meeting of Experts on Civil and Scientific Applications of Treaty Verification Technology to broaden the benefits to society of data, information and technical systems being implemented as part of the Treaty's requirements. It is felt that the promotion of broader utilization of data and information from the Treaty's International Monitoring Network will encourage an increase in the number of Signatory States and the successful ratification of national commitments to the Treaty's requirements. Mr. Chen made a presentation with Health Canada on meteorological aspects, in particular with respect to radionuclide technologies, and explained the long standing operational practice of global open exchange of meteorological data, products and information. In addition, he also made reference to the possible application of infrasound monitoring data for detecting and locating explosive volcanic eruptions for notifying aircraft operations of the presence of airborne volcanic ash. The International Earth Observing System initiative was also presented as a parallel multinational interest in global environmental monitoring and data utilization for civil, humanitarian and scientific pursuits.

Conclusion

While it may be surprising at first, meteorology and operational meteorological systems have wide applications that extend well beyond weather forecasts and warnings. The highly specialized application to the nuclear-test-ban and CTBT Verification, in supporting both policy formulation and operational techniques, while fascinating, is also moving the meteorological science forward. It is enhancing the benefits derived from national government investments in meteorology, increasing global security and contributing to healthy environments and sustainable development.

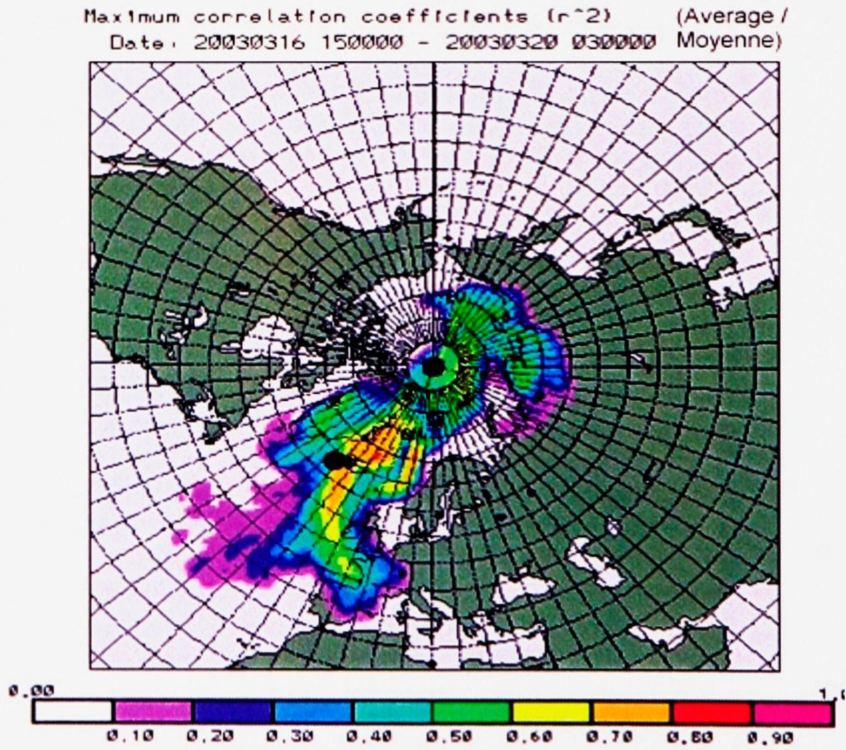


Courtesy of CTBTO - Courtoisie de OTICE



Courtesy of CTBTO - Courtoisie de OTICE

Determination of the location of a 'virtual' nuclear detonation done during an international exercise in March 2003: The actual 'virtual' location is indicated by the black dot on the three panels. On all panels, the colors correspond to the probability that an explosion has taken place. The results presented are from the Comprehensive Nuclear-Test-Ban Treaty Organization and the Canadian Meteorological Centre (upper left and upper right images, respectively) and the average from the 10 participants to the exercise (right image). This technology, when used together with the other three detection techniques, will be able to determine the location of an illegal nuclear detonation taking place in the atmosphere, underground or underwater within 1000 square kilometres. Participating countries were Canada, the United States, the Russian Federation, Japan and the United Kingdom.



Courtesy of CTBTO - Courtoisie de OTICE

Plans 2004-2005

Information Technologies (IT) and Telecommunications

The MSC 24/7 operations will continue to rely heavily on advanced systems, networks and specialized applications requiring expert level computer scientists to install, operate and provide continuous operational maintenance, support and problem resolution. These activities take up the majority of the IB Dorval IT resources (80-90%).

The new IBM supercomputer was accepted December 25, 2003 and is now in full production. The NEC systems are expected to be removed early in the year. Several more months of work will be required to stabilize and fine tune the IBM operating environment. Planning work for the next upgrade will begin in the fall.

The last contract upgrade to the Silicon Graphics (SGI) Front-Ends, begun last year, will be completed and a project initiated for their replacement as the current contract expires in April 2006. User requirements and technical specifications for a Request For Proposal (RFP) will need to be established in the next few months.

The Central File System (CFS) contract will also be extended and, pending funding, migration of our old D2 tape archives to new LTO tape technology will begin. The CFS system cannot sustain the current archive growth rates and a stable longer term growth and funding strategy needs to be established for CMC's near-line storage.

The coming year will see the installation, replacement or upgrade of many other operational systems such as the Product Distribution System (PDS), the ECONAS climate archive system; the National Communications processor (NCP); and the National URP radar processing cluster.

On the telecommunication side, we will continue to manage the ECONET and make sure it meets the needs of MSC and Environment Canada. We will ensure that proper security, with firewalls, is maintained and improved to avoid putting our operational systems at risk.

The reorganisation of the service (FFF) will require some adjustments and changes to the ECONET. A user requirements survey will be sent out early in the year. Funding has been approved for the replacement of the SATNET receiver stations across the service and this activity is planned for next fall.

We will continue to manage other MSC networks such as AMIS, our component of the Global Telecommunication System (GTS) and others as needed. With the completion of the GOES-90 replacement project in early spring, we plan to improve the support infrastructure through the use of the SMB to host a self-contained software bundle for the new GOES systems. We will also develop procedures to access the GOES national spares. Telecommunication and data services support will be provided to the Department of National Defence (DND), Nav Canada and others clients and partners as per contractual agreements or MOU. A Service Level Agreement (SLA) for ECONET and other national services that are provided by CMC will be developed jointly with the EC IM/IT directorate. A proposal for the longer term life cycle management of ECONET equipment will also be developed.

CMC will continue to improve and maintain the national real-time single window weather web site. It will continue to evolve in line with the Government On-Line initiative, and follow the common look and feel guidelines. A new portal for use by Health Canada will be deployed, as well as the incorporation of the media portal, marine pages and several other technical improvements into the weatheroffice infrastructure. We will work on the renovation of the MSC Greenlane internet site.

The work on the NCS replacement project will continue. The replacement of the Tandem data switch is a large project. The Tandem computer is used to switch all observations and all warning and forecasts bulletins and is key to all exchange of data within MSC and to national clients as it feeds other distribution systems such as Satnet and the Weather Office web site. Limited funding last year slowed down Tandem replacement activities. The Tandem replacement strategy will also need to be re-evaluated in light of the new Data management Framework (DMF) projects.

Work will continue, in collaboration with the Regions, to improve the maintenance and support of national applications by managing the Software Management Board (SMB) repository of source codes and leading the development of SMB national software development standards. The CMC will take the lead of the new Configuration Management Office (CMO) to ensure the implementation of standardized configuration and software for production.

We will provide IT services to AMWSD by leading significant development on three DMF sub-projects including data acquisition and switching, storage elements (production database) as well as core services and architecture elements. CMC will also continue to provide IT resources and expertise in the development of the "workstation of the future" project (NINJO) and pursue the on-going maintenance and support of critical operations and national software. Several of these national applications will be ported from an obsolete computer platform to a Linux platform.

Work continues to move all Dorval IT assets to the new computer room. It is estimated that at least one more year will be required to complete the move.

The Downsview LAN infrastructure upgrade to provide additional redundancy and meet increasing bandwidth demands will be completed. We will continue to work with the national IM/IT directorate on Office Technology client and server side upgrades, national standards and collaboration tools. Service improvements to remote sites will be a priority.

Contingency plans for the CMC and the MSC will have to be reviewed in light of the MSC reorganisation and the upcoming departmental Business Continuity Plan (BCP). Issues related to longer term contingencies (second site backup for data acquisition & distribution systems such as the Tandem and weather-office) need to be considered in future planning exercises.

Finally we will pursue our efforts to improve the security of our systems, networks and installations. Several security initiatives are planned for next year: improvements to our virus tracking, systems deployment and patching tools; implementation of a remote access zone and a standard secure remote access platform, test and deployment of new intrusion detection systems, improvements to SPAM filtering, implementation of a web monitoring system, development of a modern departmental IM/IT architecture...

Numerical Weather Prediction Systems

As a result of the dramatic changes in the MSC's forecast production program, the CMC will continue to place heavy emphasis on numerical weather prediction systems and on post-processing. An increase in the accuracy and reliability of these systems is essential if the atmospheric and environmental forecasting program is to be reliable and of high quality.

The year 2003, now behind us, saw substantial efforts to convert our operational systems to the new IBM supercomputer, and this left very little time for scientific improvements in the areas of data assimilation and modeling. Over the next two years, major changes are expected in data assimilation, NWP models and post-processing; the basis of the MSC's forecasting system.

In addition to scientific improvements to our systems, we will be investing significant efforts in technology transfer from research to operations. Unification of the computer environment and scripts used by the R&D and operational groups is an objective that will certainly be expensive to achieve but will pay dividends in the long run by greatly simplifying technology transfer and the validation work that necessarily accompanies implementation. In order to avoid slowing down scientific improvements, we will use a step-by-step approach in which the computer environment and scripts used in each link of the operational chain are simplified and harmonized. The first two components to undergo such harmonization will be the ensemble Kalman filters (EnKF) as an assimilation method in the ensemble forecasting system, and the 4D-Var analysis. The other components will gradually be incorporated and converted to this approach.

a) Global system

Major changes are planned over the next 2 years in the global forecasting system, affecting both data assimilation and the model itself.

- New data will be ingested in the assimilation system. AMSU-A data from the AQUA satellite, radiances from the GOES-12 water vapour channel, data from wind profilers, and SATWINDS from the MODIS satellite will be added to the operational system. In addition, all the ATOVS data will be subjected to variational quality control in the assimilation algorithm. We will also be working on ingestion of winds from Quickscat, and we expect to ingest the SSMI and SSMIS radiance data, affecting the humidity fields and surface winds. R&D work on assimilating data from AIRS is already under way so that it can be used in our operational assimilation systems. Finally we will be making operational use of the Canadian AMDAR data. These changes will be coordinated with changes in the global forecasting model used in the assimilation system, notably a plan to raise the top of the model from 10 hPa to 0.1 hPa so that several additional channels from the stratosphere can be assimilated.

- R&D work on the 4D-Var assimilation system is progressing as planned. We are now at the final stage of testing and the assimilation cycles in development mode are being done using the configuration which will be proposed for operational implementation. Introduction of the 4D-Var system will go hand in hand with a significant increase in the quantity of assimilated observations, including many which could not be assimilated within the 3D-Var system. This is especially important for observations with high temporal frequency such as aircraft data. The 4D-Var system will be delivered to operations for a parallel run in the fall of 2004.

- The next significant implementation of the global model will be a version with a horizontal resolution of about 0.4°, and over sixty vertical levels. Numerous improvements will be made to the parameterization of physical processes: ISBA (Interactions Soil Biosphere Atmosphere) surface scheme; Kain-Fritsch convection scheme; changed cloud-radiation interface; reformulation of the shallow convection and boundary layer schemes. This parameterization is similar to that sought for the implementation of the regional model with resolution of 15 km; as a result, the R&D effort required to develop and maintain the anticipated version of the global model will be much simplified. This implementation will follow that of the 4D-Var assimilation system.

- Finally, there will be changes in the surface fields reflecting the new parameterization and the increased resolution. These changes will for example affect the analyses of water body temperatures (use of higher resolution satellite data, e.g. ATSR), of ice cover and thickness, and of parameters related to snow on the ground. Similar changes appropriate to the regional forecasting system will also be implemented.

b) Regional system

- A new version of the regional model will be implemented in spring 2004, after the new IBM computer comes on line. Horizontal resolution at the centre of the grid will be increased from 24 to 15 km, and the number of vertical levels will rise from 28 to 58. A new set of physical parameters should correct the well known defects of the existing system and improve the system's overall performance, especially with regard to precipitation-related parameters. This is a major implementation because it will include an almost total reworking of all the physical parameters in the model.

- The new data to be assimilated in the global system will also be assimilated in the regional system.

- Use of a very wide range of additional data (from aircraft and remote sensing), already assimilated for 06 and 18 UTC, could allow an increase in the number of runs, to four a day. This will require a study of the current regional assimilation cycle strategy (every 12 hours) and of the additional benefits of intermediate runs.

c) HIMAP and very high resolution GEM model

- The HIMAP model (a version of the GEM model with a resolution of 10 km) will continue to be operational for some time yet. Development of a GEM version with higher resolution in reduced windows continues, in cooperation with Research Branch and Pacific & Yukon Region. A version with a horizontal resolution of 2.5 km centred over British Columbia is currently being tested and will be implemented. This will allow for an improved representation of surface fields in this topographically complex region, yielding more realistic forecast fields for temperature and precipitation than those provided by the regional model. The SCRIBE system will be evaluated using the 2.5km model in the context of its operational use in forecast preparation. However it is anticipated that it will be necessary to develop a statistical forecasting system using as inputs the outputs of this model to meet the needs of the public forecasting system (e.g. probability of precipitation).

- After this initial implementation, versions of the model with windows centred over southern Ontario and Quebec as well as the Atlantic provinces will also be developed. However it is unlikely that implementation in the operational chain will be possible before the first upgrade of the IBM supercomputer, expected in spring 2006.

d) Monthly and seasonal forecasts

- The 90-day outlooks will be produced and disseminated monthly rather than quarterly as at present. Besides issuing these outlooks for months 1, 2 and 3 on the first day of month 1, a further set of outlooks will be issued one month before the beginning of the valid period.

- In addition to deterministic forecasts for the various categories of temperature and precipitation anomaly, the 12 members of the ensemble used in the seasonal forecasting system will be used to provide probabilistic forecasts of temperature and precipitation anomalies for each category. The probability classes, initially not calibrated, will then undergo calibration and implementation.

- MSC research groups will be working more closely with the universities with a view to improving the quality of seasonal forecasts and estimating their reliability, as well as adding the GCMIII (General Circulation Model version 3; Canadian Climatic Model) and GEM models to the seasonal forecasting system. The SEF model originally used in the system will continue to be used until the next computer conversion, because it can improve the quality of the forecast produced by the ensemble system. In addition, cooperation with NCEP will be undertaken in order to accelerate development and implementation of a seasonal forecasting system that amalgamates the forecasts arising from both centres' seasonal forecasting models.

e) Ensemble forecasting system

- The assimilation schema for ensemble forecasts (Optimal Interpolation) will be replaced by the ensemble Kalman filter (EnKF) technique, and delivered to operations as a parallel run in the fall of 2004.

- The ensemble system forecasts will then be extended from 10 to 15 days. Also, the resolution of the models used in the ensemble system will be increased, and the system will be run at 12 UTC in addition to the present 00 UTC run. The criteria for optimizing the benefits from increasing the resolution and increasing the number of members in the ensemble have yet to be precisely identified. However use of ensemble forecasts in the context of predicting high-impact weather events will probably require an increase in the resolution of the models driving the various members of the system.

- The joint CMC-NCEP R&D/implementation project will continue. In the fall of 2004, the two centres will exchange forecasting data from their ensemble systems. This will then lead to implementation of a post-processing (debiasing) system and to development of joint products ultimately based on the combined ensembles.

f) Other modeling developments

- Version 4.5 of the WAM wave model will replace the current operational version. It will operate at a resolution of 0.5° (as compared to 1° for the current version). It will be driven by the global model over the window covering the eastern portion of the Pacific Ocean, and by the regional model over the western Atlantic. It will also run over the Great Lakes, with a 'shallow water' version to predict waves on Lake Erie.

- We also plan to develop and implement an atmospheric model linked to an ocean model for the St Lawrence Estuary. Studies have clearly shown the impact of an interactive ice field on the quality of the forecasts of atmospheric variables.

g) Statistics and post-processing

- We will finish work on all our statistical guidance for 0-48 hours based on the Updatable Model Output Statistics (UMOS), with the addition of cloud cover forecasts, followed by probability of precipitation accumulation (PoPA) forecasts. At that point, all the statistical forecasts drawing on the regional model will be UMOS-based.

- We will modernize all the statistical guidance currently based on the Perfect Prog (PP) approach by developing statistical models based on NCEP reanalyses. The guidance based on the PP approach will continue to be used for medium-range forecasts, for post-processing of ensemble forecast outputs, and perhaps even as predictors in the UMOS system.

- Statistical integration of observation data with SCRIBE data will improve the quality of short-term public forecasts produced by SCRIBE. The project to incorporate surface observations, radar observations and lightning data into SCRIBE continues. An experimental version of SCRIBE using this approach will be delivered to operations in 2004, and an improved and more robust version, with input from the CMC's operational production chain, will follow.

- Significant improvements will be made in the SCRIBE system. SCRIBE will also benefit from the improvement of short-term inputs resulting from the integration of statistical and numerical guidance with observed data. In the aftermath of the 2002 workshop, where key improvements needed in the user interface were identified, a version of SCRIBE incorporating the most critical changes will appear at all offices in the fall of 2004.

- The version of SCRIBE used to produce marine forecasts will be improved. The text generator will be changed to reflect the new production standards for marine forecasts to be adopted during 2004, and a local effects module will be included. An initial version of marine SCRIBE based on the new terminology standards will be delivered in early 2005.

- A number of new products based on the ensemble system will be developed. Once the forecasts are extended to 15 days, products dealing with days 7 to 14 will be developed and implemented. Probabilistic forecasts of various parameters will also be part of the operational production system. Currently weather forecasts are issued for the next 5 days, but developments related to the ensemble forecasting system will make it possible to extend the forecast to day 7 or perhaps even day 10.

- The computer code used in post-processing applications has not undergone a major overhaul for many years. Modernization will be undertaken as of 2004, and this should make it possible to facilitate system maintenance and performance in the future, and to standardize the approach used at CMC for post-processing activities.

Operational runs

Changes to the operational runs

Introduction

During 2003, many changes were made to the informatics infrastructure at the Centre. Beginning in early January, the NEC/SX-5 backend machine was replaced by the NEC/SX-6. Then, in February, the SGI O-2000 front-end server was upgraded to a new O-3000 version. Migration of the operational runs to the new machines required significant effort on the part of many people, from both R&D and operations. An even greater involvement was required over the remainder of the year to migrate the runs to the next generation supercomputer, the IBM, which became operational in early January 2004. Consequently few improvements of a scientific nature were made to the operational runs during this period.

Changes in operational runs in 2003

a) In January, the operational runs were moved from the NEC/SX-5 supercomputer to the NEC/SX-6 machines

b) In February, the GCM model was officially introduced in the operational run suite for the production of seasonal forecasts. Prior to that, the model had been producing the official forecasts out of a development account.

c) In February, the operational runs were moved from the SGI O-2000 front-end server to SGI O-3000 version.

d) In April and May, a distributed memory version of the GEM model running in regional and global configuration was implemented in the operational runs. Also, hourly outputs were introduced in the regional GEM operational database to meet increasing user requirements.

e) On 19 June, a change was introduced in the global data assimilation system to make use of satellite radiance data from the AMSU/B satellite instrument in addition to the data from the AMSU/A instrument which were already assimilated. As well, the assimilation of IR radiance data from the 6.7 micron channel on the GOES-W was introduced. The AMSU instruments are part of the ATOVS sounder on-board the NOAA-15, NOAA-16 and NOAA-17 satellites.

f) At the end of December 2003, the following components of the operational run system were ported to the new IBM machine: the ensemble prediction system and the CHRONOS air quality model.

Description of operational runs as of December 31, 2003

Global **atmospheric and environmental forecast system**

The medium range forecast system, out to ten days, covers the entire globe. The full forecasting cycle runs twice per day, based on observations at 00 and 12 UTC (Universal Time Coordinated). The model is run to 6 days based on 12 UTC data and to 10 days based on 00 UTC data; on Saturdays it is run to 15 days based on 00 UTC data. Analyses are produced at 00, 06, 12 and 18 UTC. This system serves as the basis for 3-day, 4-day and 5-day forecasts.

Systems	Products	Components	Resolution
Data assimilation	Quality control of data and numerical analysis of temperature, wind, humidity and surface pressure	3D-VAR (three-dimensional variational analysis))	100 km horizontally; 28 *eta* levels vertically
Numerical weather prediction	Wide variety of charts, images, numerical data feeding other components, etc	GEM 'global' configuration (GEM=Global Environmental Multiscale)	100 km horizontally; 28 *eta* levels vertically
Environmental emergency response	Forecast or diagnostic trajectories	CANERM (CANadian Emergency Response Model)	50 km horizontally; 25 levels vertically
Numerical prediction of wave heights	Pacific wave heights	WAM (Wave Model)	100 km
Forecasts of weather elements	Wide variety of guidance for public and aviation forecasting	Perfect Prog Specialized algorithms SCRIBE matrices	264 stations in Canada GEM model grid 1145 points

Regional **atmospheric and environmental forecast system**

The short range forecast system (to 2 days) covers North America and adjacent oceans north of 30 degrees latitude. The full forecasting cycle runs twice per day based on the observations at 00 and 12 UTC. Analyses are produced at 00, 06, 12 and 18 UTC.

Systems	Products	Components	Resolution
Regional assimilation of upper-air data	Quality control of data and analysis of temperature, wind, humidity and surface pressure	3D-VAR (three-dimensional variational analysis)	24 km horizontally; 28 *eta* levels vertically
Regional assimilation of surface data	Quality control of data and analysis of surface humidity and temperature	OI (Analysis based on Optimal Interpolation method)	24 km horizontally;
Numerical weather prediction	Wide variety of charts, images, numerical data feeding other components, etc	GEM regional configuration (Global Environmental Multiscale)	24 km horizontally; 28 *eta* levels vertically
Numerical prediction of air quality	Forecast concentrations of various atmospheric pollutants (O_3, SO_4, SOA)	CHRONOS (Canadian Hemispheric & Regional Ozone & NOx System)	21 km horizontally; 20 *Gal-Chen* levels vertically
Numerical prediction of wave heights	Atlantic wave heights	WAM (Wave Model)	100km
Environmental emergency response	Forecast or diagnostic trajectories	CANERM (CANadian Emergency Response Model)	25 km horizontally ; 25 *eta* levels vertically
Forecasts of weather elements	Wide variety of guidance for severe weather forecasting, public forecasting and aviation forecasting	Perfect Prog UMOS (Updatable Model Output Statistics) Specialized algorithms SCRBIE matrices	264 stations in Canada 674 stations in Canada GEM model grid 1145 points

Local atmospheric and environmental forecast system

The very short term forecast system (24-36 hours) covers parts of North America. The initial conditions are provided by short-term forecasts from the regional system issued at 00 and 12 UTC.

Systems	Products	Components	Resolution
Experimental numerical weather prediction	charts on the Web and numerical data	GEM high resolution regional configuration (GEM=Global Environmental Multiscale)	10 km horizontally; 35 *eta* levels vertically
Experimental numerical weather prediction	charts on the Web and numerical data	GEM local configuration. Project carried out in cooperation with the Pacific and Yukon Region (PYR) (GEM=Global Environmental Multiscale)	2.5 km horizontally; 42 *hybrid* levels vertically

Analyses of surface fields:

Analyses of surface parameters are vital to the operation of all components of the forecasting system because they make it possible to correctly describe boundary conditions.

Products	Assimilation	Resolution
Air temperature near surface (00, 06, 12, 18 UTC)	Optimal Interpolation	0.9 x 0.9 degrees lat-lon Global grid GEM regional model grid
Dew-point depression near surface (00, 06, 12, 18 UTC)	Optimal Interpolation	0.9 x 0.9 degrees lat-lon Global grid GEM regional model grid (18 UTC only)
Sea-level pressure every 6 hours (00, 06, 12, 18 UTC)	Optimal Interpolation	0.9 x 0.9 degrees lat-lon Global grid
Snow depth (00, 06, 12, 18 UTC)	Optimal Interpolation	0.33 x 0.33 degrees lat-lon Global grid
% sea ice coverage (00 UTC)	Averaging of data with return to climatology in areas where data are not available	0.33 x 0.33 degrees lat-lon Global grid

Probabilistic atmospheric and environmental forecast systems

The ensemble forecasting system and the long-term (monthly and seasonal) forecasting system both use multiple model runs as a method of dealing with forecast uncertainty. These systems cover the entire globe.

Ensemble forecasting system

The ensemble system (which forecasts to 10 days) runs once a day based on the 00 UTC analyses. Perturbed analyses (8) are produced every 6 hours (00, 06, 12 and 18 UTC).

Systems	Products	Components	Resolution
Data assimilation	Quality control of data and analysis of temperature, wind, humidity and surface pressure	Analysis based on the Optimal Interpolation method with perturbed observations	150 km horizontally; 21 *sigma* levels vertically
Numerical weather prediction	Wide variety of charts, images, numerical data based on the 16 member forecasts of the ensemble and the forecast from the global system	8 different configurations of the GEM model (GEM=Global Environmental Multiscale) 8 configurations of the SEF model (finite element spectral model in the vertical)	135 km horizontally; 28 *eta* levels vertically 135 km horizontally; configurations with 23 and 41 *sigma* levels vertically

Monthly and seasonal forecasting system

The monthly and seasonal forecasting systems are also ensemble systems but use a sequence of global model analyses (all valid at 00 UTC) from consecutive days as perturbed analyses. The monthly forecast is produced twice per month, while the seasonal forecast is produced once per season (quarterly).

Systems	Products	Components	Resolution
Monthly forecast	Outlook for temperature anomaly	SEF model (finite element spectral model in the vertical)	166 km horizontally (T63); 23 *sigma* levels vertically
Seasonal forecast	Outlook for temperature and precipitation anomalies Confidence level	GCM II (General Circulation Model) SEF model (finite element spectral model in the vertical)	330 km horizontally (T32); 10 *pressure* levels vertically 166 km horizontally (T63); 23 *sigma* levels vertically

You will find more information on CMC's operational runs at the following address: http://www.msc-smc.ec.gc.ca/cmc/op_systems/index_e.html.

Performance measures

1. NWP Performance

a) Global model objective scores

There was relatively little change in the performance of the Canadian Global model over North America between 2002 and 2003. A very slight deterioration in 500 hPa RMS (root mean square) errors was noted at 24 hours, with a modest improvement at 120 hours (Tables 1 and 2, Fig. 1). This is consistent with the fact that there were no significant changes to the Global forecast system in 2003, other than the addition of new satellite data to the assimilation system on two occasions.

CMC/MRB was preoccupied for much of the year with the migration of the numerical models from the NEC to the new IBM supercomputer. Hence changes to the forecast system were, of necessity, put off until 2004.

By contrast, most of the other NWP centres made changes to their forecast systems, and the Global model generally lost ground against their models. This is more evident at 24 hours than at 120 hours. The statistics below consider only the average of the U.S. NCEP and UKMO models. However, the NCEP model did relatively poorly in 2003, in spite of significant changes to their system. Overall, the Global model lost ground at 24 hours against five of the top six NWP centres.

Table 1: 24-h Forecasts

North America	RMSE: CMC	RMSE: Leading Centres	Difference (CMC- Leading Centres)
2002	12.70	12.54	0.16
2003	12.75	12.37	0.38
Improvement (%)	-0.39%	1.36%	

Table 2: 120-h Forecasts

North America	RMSE: CMC	RMSE: Leading Centres	Difference (CMC- Leading Centres)
2002	58.94	56.02	2.92
2003	57.40	54.65	2.75
Improvement (%)	2.61%	2.45%	

b) Regional model precipitation

After having made significant gains against the U.S. ETA model between 2001 and 2002, GEM Regional model lost ground this past year (Fig. 2). As always, the ETA model scores better with the smaller amounts, while GEM does better with the higher amounts. However, the point at which the lines cross fell from 12.5 mm (0.5 inch) in 2002 to 25 mm (1.0 inch) in 2003, representing a relative deterioration for the GEM model against the ETA.

As above for the Global model, there were only minor changes introduced to the Regional forecast system since 2001 (ingestion of new satellite data). NCEP, on the other hand, made more significant upgrades to the ETA system.

Nonetheless, ETA model scores were almost identical, except at the very high end, between 2002 and 2003, whereas the Regional model scores deteriorated somewhat. Hence the loss of ground against the ETA was a result of a poorer performance on the part of the GEM.

2. Surface Temperatures

As with the numerical model performance, there was little change between 2002 and 2003 with respect to the verification of surface temperature forecasts, for either the official forecasts or the SCRIBE automated forecasts (see Fig. 3). Performance of the SCRIBE forecasts remains slightly above that of the official forecasts for all three time periods. The most significant difference between the two systems is evident in the day 2 maxima, where a slight drop in performance of the official forecasts combined with a slight increase for the automated forecasts, resulted in a gap of almost 2.5%, in favour of SCRIBE.

3. Operational Runs

There were a total of 22 cases in 2003 where at least 10 regional or global model charts were delayed by at least 10 minutes - an efficiency of 97.0% (22 runs out of 365 days x 2 runs/day). Four of these were major delays of 2 hours or more. The overall number of incidents is about the same as for the previous year (20 cases), but there were twice as many major delays. In addition, three of the major events were of particularly long duration, attaining 5, 8 and 10 hours respectively. This is the third year in succession where the 98% standard was not met (Fig. 4).

Of the delays, 11 were attributable to software problems, 6 to hardware problems and 2 to network problems, while 2 others were due to human error. A virus attack on Jan. 25th was responsible for the remaining event, and resulted in a delay of 2 hours. The other major events were due to a problem with the GEMDM (GEM Distributed Memory) code on the NEC (5 hour delay), a network problem between the NEC and the front-end machine (8 hours) and a disk failure on the NEC (10 hours).

Five of the hardware problems were related to a series of disk problems on the NEC during the first quarter. The other hardware incident was network related.

The software problems occurred mainly on the supercomputer. In a couple of instances these were compounded by human error or a hardware problem on another machine. In each case procedures were updated or a failsafe implemented. Informatics has ensured that the identified software problems have not been ported to the new IBM machine. As well, work began, over the course of the year, to add a level of sophistication to the automated run monitoring system, which will address a deficiency noted in last year's annual report, and allow delays in certain cases to be identified sooner.

A number of other incidents of note occurred during the year. A disk failure in February resulted in a loss of data ingest during a critical 2 hour period. Production was unaffected, but the quality of the outputs was put at risk.

Loss of CMC's ISP that month had a major impact on web-delivery of products. Unfortunately the event coincided with a major winter storm affecting the most populous part of the country. Redundancy in the provision of Internet services has been instituted since then.

The major power outage affecting Ontario in August did not affect production at CMC, but had an impact on web-delivery, and also on data transfers from Ontario.

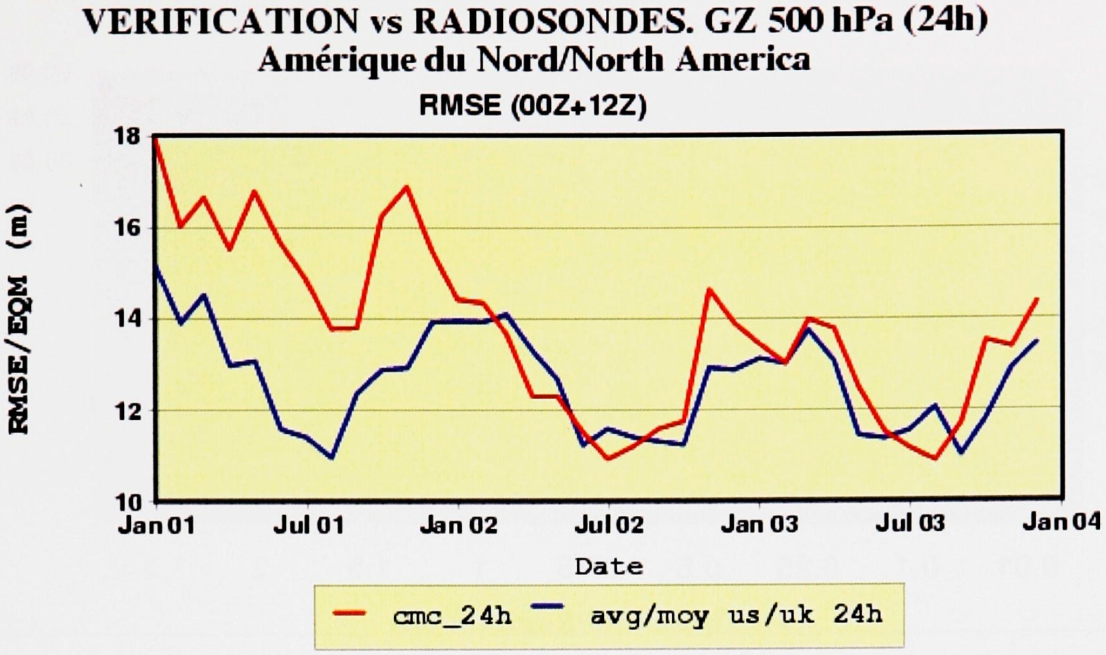
Finally, appropriate steps were taken during another major international virus attack in August which successfully prevented any negative impact on CMC production.

4. Computer Availability

Availability of both the operational front-end and supercomputer machines (Fig. 5) was above the 97% target rate for all months in 2003.

5. Weatheroffice.ec.gc.ca Usage

Usage of the Weatheroffice.ec.gc.ca web-site increased significantly between 2002 and 2003 (see Fig. 6). Over the course of 2002, average daily usage varied slightly from month to month, but started to increase rapidly with the approach of winter, and the introduction of a weather warning display page in November 2002. Usage peaked in Jan-Feb 2003, but levelled off at a significantly higher level than in 2002. For example, the average number of daily visits was about 13% higher in 2003 vs. 2002. Furthermore, visitors to the site were viewing on average about 15% more pages with each visit. Taken together, this corresponded to an overall increase of about 30% in the average number of daily pages viewed per month.



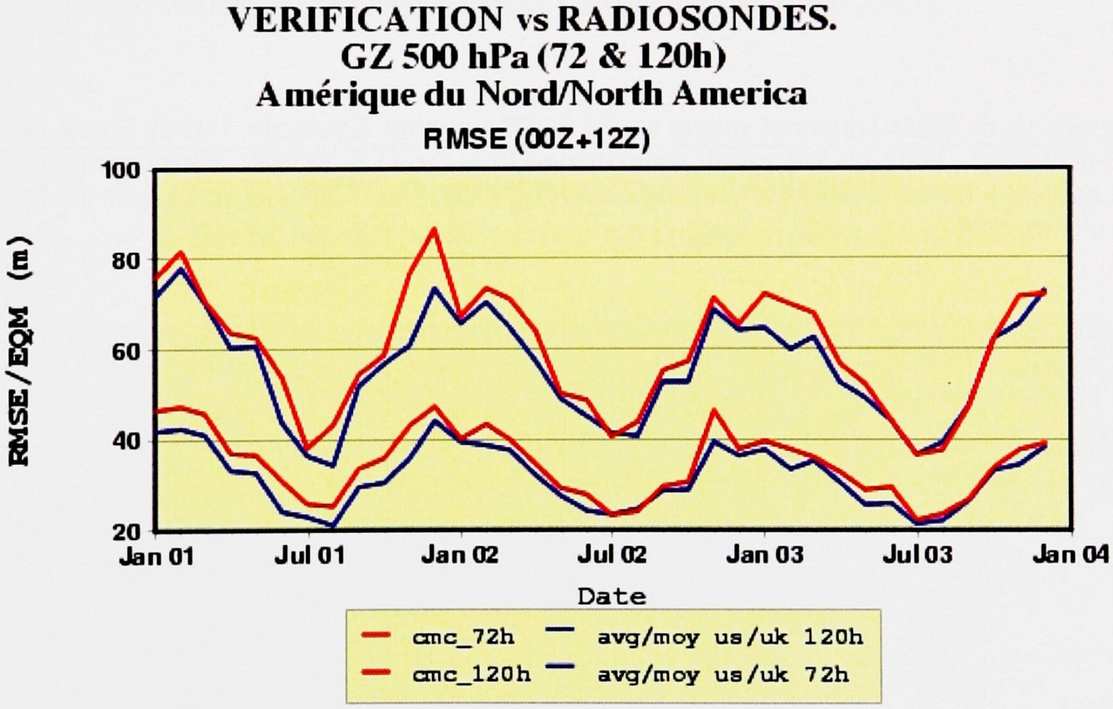


Figure 1: Comparison of 500 hPa geopotential height RMS errors between CMC global model and the average of the UKMO and U.S. NCEP global models for the period Jan. 2001 to Jan. 2004.

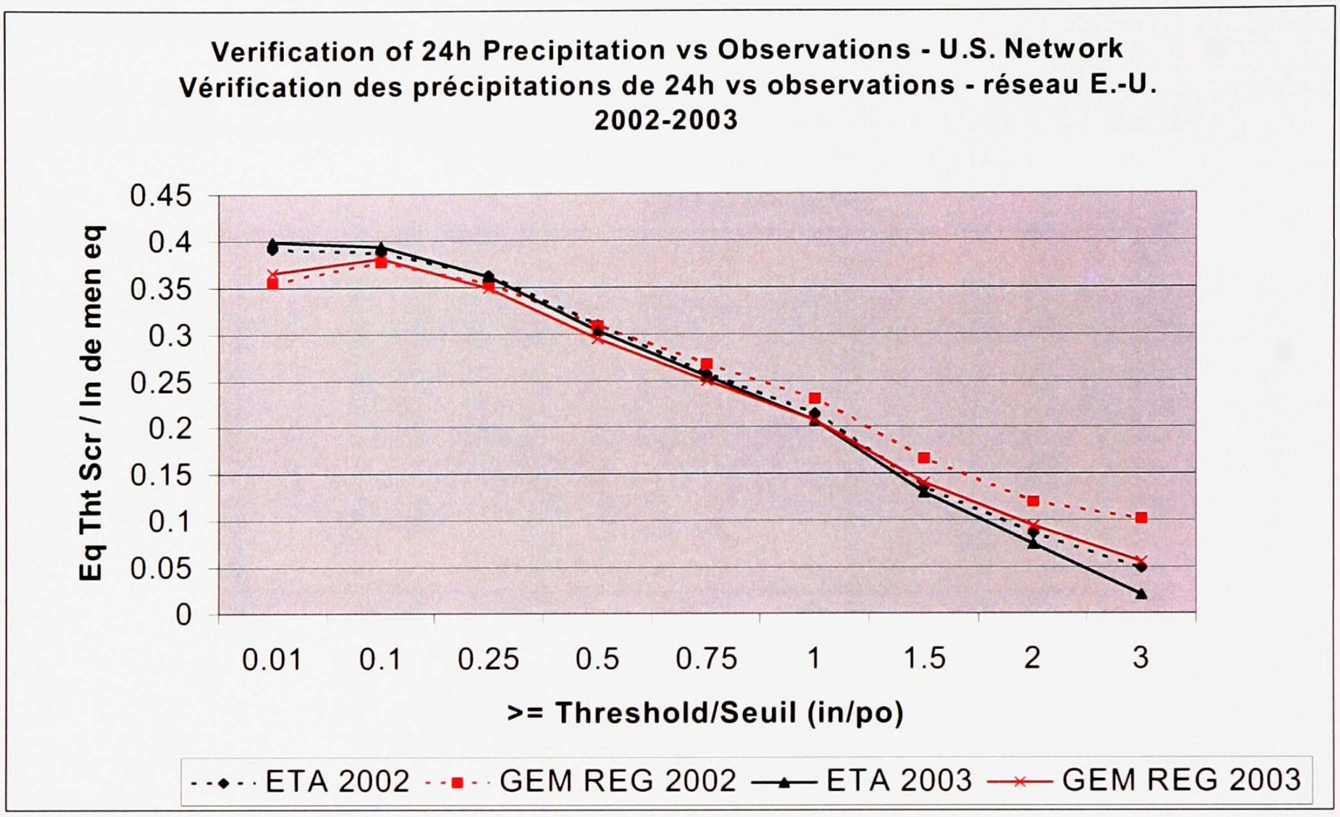


Figure 2: Comparison of GEM Regional model vs. U.S. ETA model Equitable Threat Score between 2002 and 2003. Data for this graph are obtained from the U.S. NCEP. Performance is measured against a dense network of surface observing sites (the SHEF network) over the lower 48 states of the U.S.

A Threat Score is a measure of relative precision in a category, and is defined as:

 # correct forecasts for a category /
 # events (forecast or observed) in that category

The Equitable Threat Score presented here further takes into consideration the number of correct forecasts that would be expected purely due to chance. The score varies between -1/3 and 1 (the latter representing a perfect forecast).

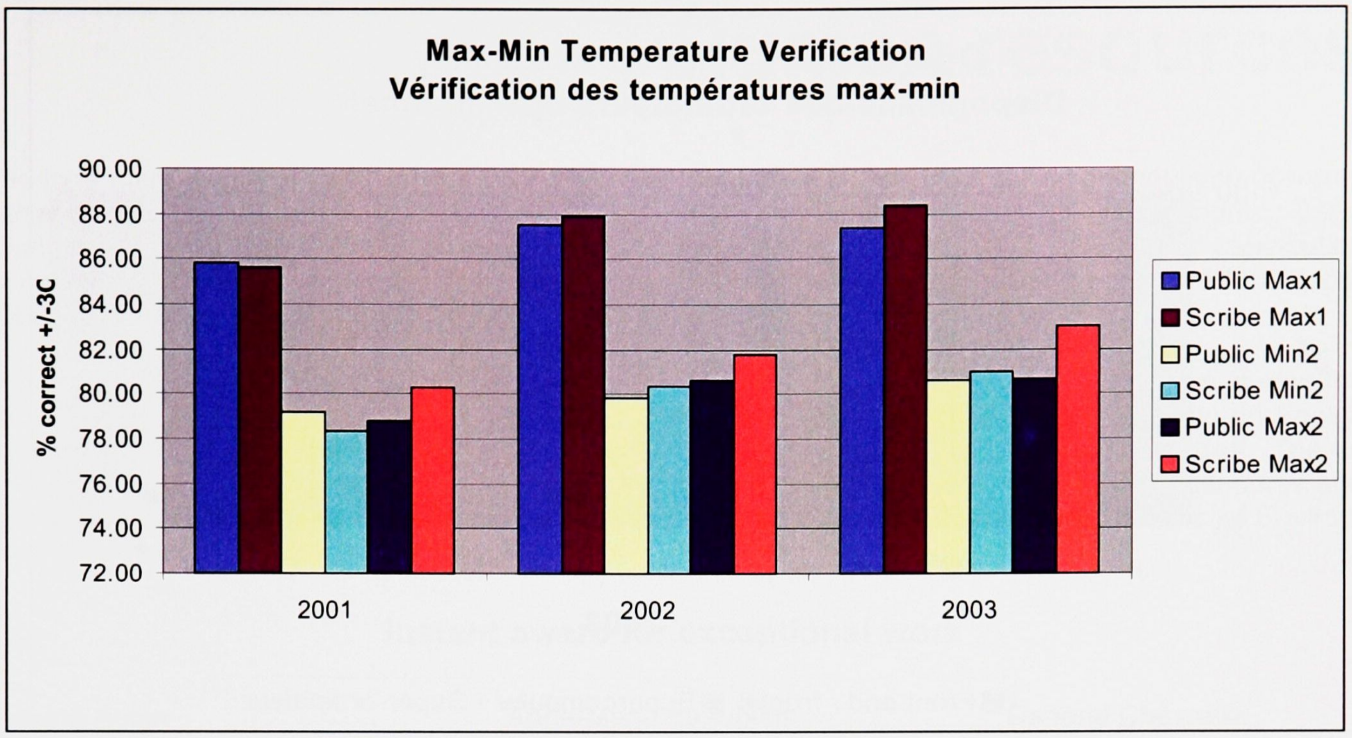


Figure 3: Percent correct of SCRIBE and official public forecast temperatures to within +/- 3°C of observed values, at 118 stations across Canada, for years 2001-2003.

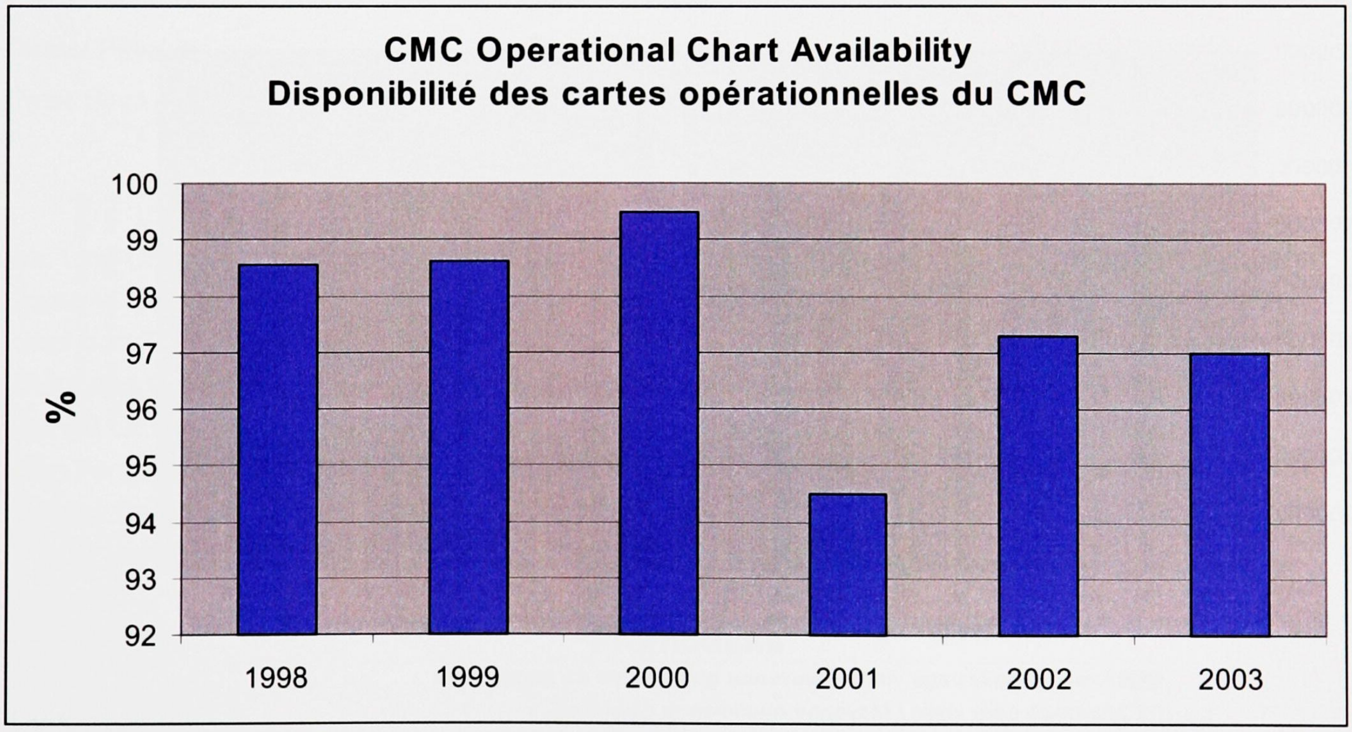


Figure 4: Availability of the operational charts (regional and global runs) within 10 minutes of their scheduled times for the years 1998 to 2003.

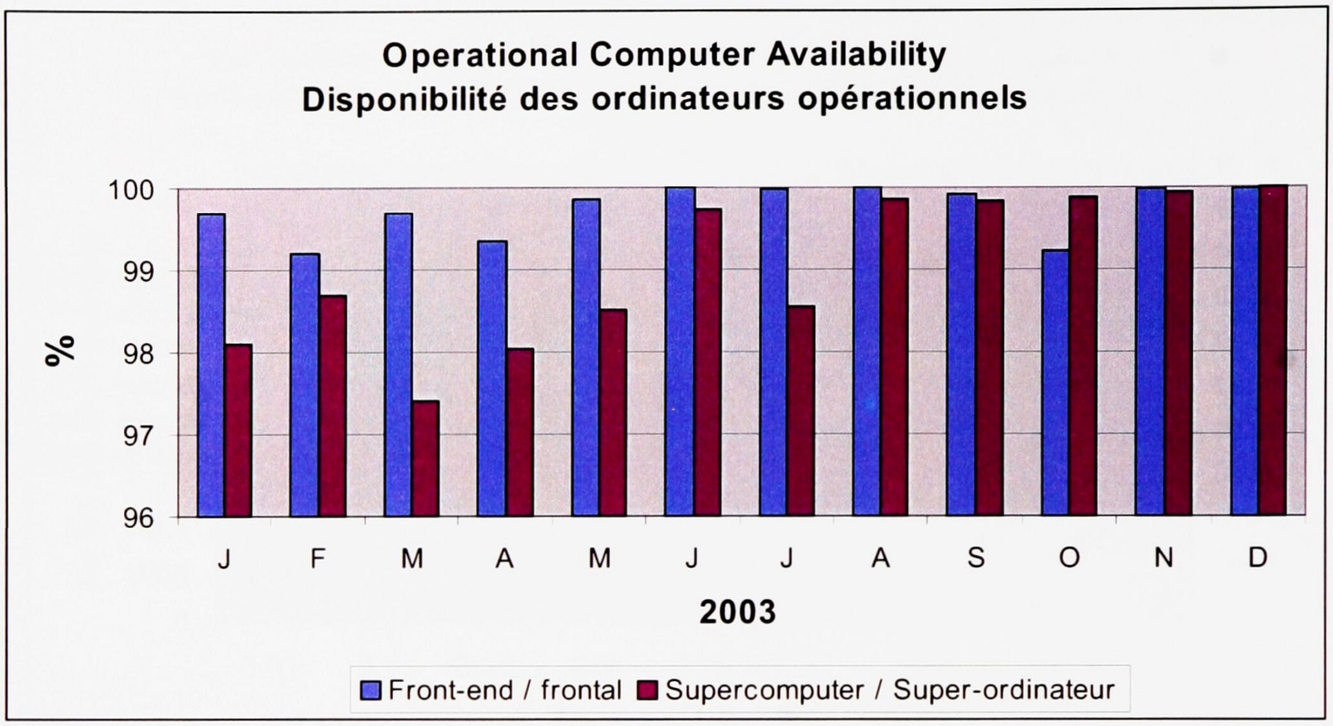


Figure 5: Operational computer availability. This includes down-time resulting from routine maintenance, user software problems etc., and has a performance benchmark of 97%.

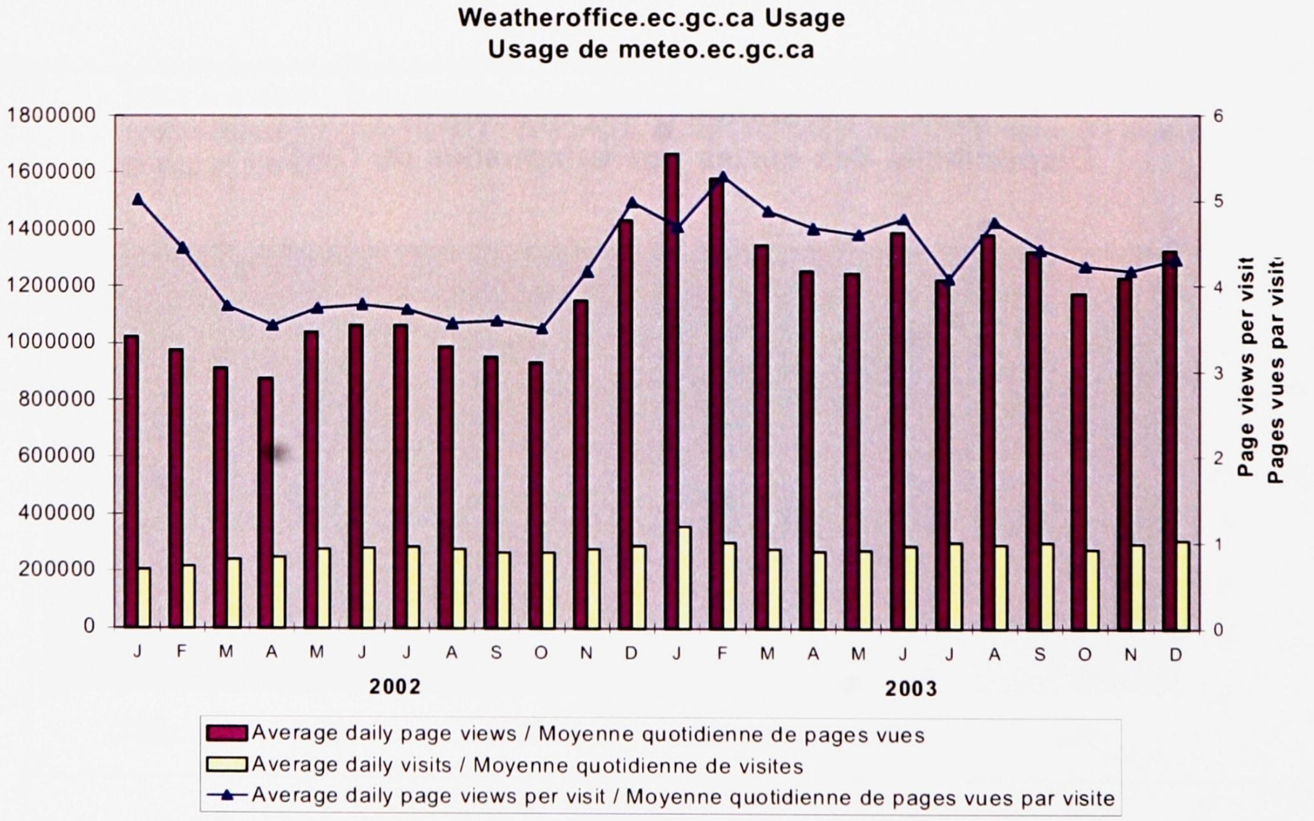


Figure 6: Usage of the Weatheroffice.ec.gc.ca web-site, by month. The number of visits is defined as the number of times a visitor accesses the site. A page view is a hit to a file designated as a page

Human resources

The lone merit award at CMC for the year 2003 was presented in February, for an event which occurred between July and October 2002. This award was given to Paul Arseneault, Luc Beauchamp, Denis Filiatrault, Pierre Paul and Diana Massey, of the CMISQ group, to recognize their exceptional contribution in maintaining informatics operations during a period of personnel shortage between July and October 2003.

In addition, an instant award was given to the following group of people for exceptional work during the "*MSSQL Slammer*" denial of service worm attack. MSSQL Slammer started propagating late on Friday, January 24, 2003, and affected certain MSC applications during the night of Friday to Saturday. The intervention team identified the source of the problem, and quickly put in place contingency measures and implemented fixes, so as to minimize repercussions on essential infrastructure and services of Environment Canada.

Instant award for exceptional work

Roland Aubin
Luc Beauchamp
Guy Dansereau
Alain Guillotte
Monique Loiselle
Pierre Ménard
Daniel Pélissier
Peter Silva

Anne-Marie Beaubien
Doug Bender
Réjean Dumas
Carol Hopkins
Denis Marchand
Claude Mercier
Claude Rancourt
Nadine Vibert

Darlene Chevrefils
Richard Crawshaw
Josée Fortin
Carol Krupat
John Marshall
Diane Ouellette
Walter Richards

New employees

Mu Ling Chou
Jeramie Iacobucci
Shaheed Sufi
Stéphane Gaudreault
Gérald Lacasse
Jian Feng
Gaétan Deaudelin
Michel Van Eeckhout

James Fricker
Paul Marchant
Zeshan Zafar
Hugo Landry
Victor Demanins
Lu Ying Liu
Ashley Jean-Marie

Teh (Thomas) Gibson
Ahmed Yusuf Mulla
Daniel Lemay
Anh Le Ngoc
Chantal Côté
Nathalie Da Silva
Magda Little

Promotions

Delroy Barrett
Patrick François
Michel Jean
Pierre Michaud
Lise Rivard

Luc Corbeil
Stéphane Gaudreault
Daniel Lemay
Ovando Prescod
Charles Schwartz

Antoine Duval
Aubin Guillemette
Lu Ying Liu
Farid Rebbas
Dao Vuong (Vincent) Vu

Departures

Nadine Vibert
Maryse Sohier
Victor Demanins
Antoine Duval

Retirements

Lionel Lane
Luc Poitras
Gaston Lemieux
Gilles Richard

Long Service Awards

Thirty-five years of service

Karl Rasl
Lionel Lane

Thirty years of service

Jean-Guy Desmarais
Jean-Guy Babineau
Denis Filiatrault
Denis Bachand
Jacques Saint-Hilaire
Robert Sauvageau

Twenty-five years of service

Howard Bordman
Luc Poitras
Gaétan Desjardins
René Servranckx

Employee activities

CMC employees are recognized for their involvement in various social and athletic activities throughout the year. Many activities took place in 2003.

Kelvin Band, once again put on several shows in 2003. The band, formed 12 years ago for the CMC Christmas party, consists of employees from various disciplines working at the Dorval facility.

The Kelvin Band at work at the annual congress of the Canadian Meteorological and Oceanographic Society.

Social dance classes continue to be very popular. Tai chi and Pilates classes are also enjoyed by many. Athletic activities during the year included evening hockey, tennis and soccer games. Many people also participated in the annual hiking, biking and golf day in September, which allowed staff to take some fresh air together.

As always, CMC and Research employees participated actively in the 2003 United Way Campaign to raise money for people in need in the Montreal area.

At Christmas, whether at Dorval or at Downsview, the festive spirit is strong.

Is there anything better than a tug-of-war at a party after a big Christmas meal?

Contact list

CMC Contact List

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Director, Informatics Branch Angèle Simard	4765 fax: 4703	**Scientific Applications Development** Michel Baltazar	4641
Director, Operations Branch Peter Chen	4622 fax: 4679	**Informatics - Downsview** Susan Wild	(416)739-4799
Director, National Prediction Programs Martha McCulloch	780-951-8636	**Informatics - Dorval** Raymond Benoit	4710
		National Computing and Network Operations (24 hours per day)	(514) 421-4698
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Facilities Jean-Claude Goudreau	7260	**Analyses and Prognoses** Robert Mailhot	4633
Human Resources Marie Lussier	7205	**A&P Operations Desk** (24-hr)	4635
Administration Colette Labonne	4606	**Environmental Emergencies** Michel Jean	4614
		Emergency Response (24-hr)	4635
		Special Projects Rick Jones	4782

Other useful Contacts

Director General, Atmospheric and Climate Science, Michel Béland	4771	**Data Assimilation and Satellite Meteorology** David Steenbergen	416-739-4257
Director, Meteorological Research Branch Jim Abraham	4751	**Senior Analyst - RPN** Michel Valin	4753
Recherche en prévision numérique (RPN) Gilbert Brunet	4617		

Acronyms

3D-VAR	3-Dimensional Variational Analysis
ACARS	Aircraft Communication Addressing and Recording System
ADS	Aviation Defence Service
AEP	Atmospheric Environment Prediction
AES	Atmospheric Environment Service
AMDAR	Aircraft Meteorological Data Reporting
AMIS	AES Meteorological Information Service
AQMAG	Air Quality Models Application Group
AQRB	Air Quality Research Branch
AWeD	Aviation Weather Database
AWG	CBS Advisory Working Group
BUFR	Binary Universal Form for the representation of meteorological data
BURP	Binary Universal Report Protocol
CANATEX	CANadian NATional nuclear EXercise test
CANERM	Canadian Emergency Response Model
CANFIS	Classification And regression tree Neural-Fuzzy Inference System
CBC	Canadian Broadcasting Corporation
CBS	Commission for Basic Systems (WMO)
CEO	Chief Executive Officer
CFS	Central File Server
CHRONOS	Canadian Hemispheric Regional Ozone and NOx (Nitrous oxide) System
CMC	Canadian Meteorological Centre
CREX	Character form for the Representation and Exchange of data
CS	Computer Science
CTBT	Comprehensive (Nuclear) Test Ban Treaty
CTBTO	CTBT Organization
DMO	Direct Model Output
DPFS	Data-Processing and Forecasting Systems
ECMWF	European Centre for Medium-Range Weather Forecasts
ECS	Environment Conservation Service
EPS	Ensemble prediction system
ET	Expert Team
ETEX	European Tracer Experiment
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
FIR	Flight Information Region
FNEP	Canada's Federal Nuclear Emergency Plan
FTP	File Transfer Protocol
GCMIII	General Circulation Model
GB	Gigabyte (10^9)
GDPS	Global Data Processing System
GEM	Global Environmental Multi-scale (Model)
GENet	Government wide intranet
GEWEX	Global Energy and Water Cycle Experiment
GMS	Geostationary Meteorological Satellite
GOS	Global Observing System
GRIB	Gridded Binary (data format)
GTIS	Government Telecommunications and Informatics Services

GTS	Global Telecommunications System
GWMC	Government Wide Mission Critical
HIMAP	High resolution Mesoscale Application Project
HIPPI	High Performance Parallel Interface
HRPT	High Resolution Picture Transmission
IAEA	International Atomic Energy Agency
IAVW	International Airways Volcano Watch
IB	Informatics Branch
ICAO	International Civil Aviation Organization
ICT	OPAG Implementation and Coordination Team
IEEE	Institute of Electrical and Electronics Engineers
IM/IT	Information Management/Information Technology
IMS	Global International Monitoring System (CBTB)
INEX	International Nuclear Emergency Exercises
IPI	Intelligent Peripheral Interface
IXS	Internode crossbar (X) Switch
ISBA	Soil-Biosphere-Atmosphere Interactions
ISDN	Integrated Services Digital Network
LAN	Local Area Network
MDA	Multiple Discriminant Analysis
MLR	Multiple Linear Regression
METRo	Heat exchange model
MRB	Meteorological Research Branch
MSC	Meteorological Service of Canada
MOS	Model Output Statistic
NAOS	North American Atmospheric Observing System
NCEP	U.S. National Weather Service's National Centers for Environmental Prediction
NOAA	National Oceanic and Atmospheric Administration (USA)
NO_x	Nitrous oxide
NWP	Numerical Weather Prediction
NWS	NOAA National Weather Service
OPAG	Open Programme Area Group (WMO)
PDS	Product Dissemination Server
ppb	parts per billion
POP	Probability Of Precipitation
PP	Perfect Prognosis
RA	Regional Association
RAID	Redundant Array of Independent Disks
RAOBs	Radiosonde observation
RMSE	Root Mean Square Error
RPN	Meteorological Research Branch
RSMC	Regional Specialised Meteorological Centre
SAN	Storage Area Network
SATNET	Satellite Network
SCRIBE	System to assist the meteorologist in bulletin preparation
SCSI	Small Computer System Interface
SGI	Silicon Graphic Inc
SSCP	Sum of Square and Cross Product
TB	Terabyte (10^{12})
TCO	Testing and Certification Office
TCRB	Testing, Certification Review Board
TOVS	TIROS Operational Vertical Sounder

UKMO	United Kingdom Meteorological Office
UMOS	Updateable Model Output Statistics
UN	United Nations
UPS	Uninterruptible Power Supply
URP	Unified Radar Processing
UTC	Coordinated Universal Time (Greenwich Mean Time)
VAAC	Volcanic Ash Advisory Centre
VPN	Virtual Private Network
WAM	Ocean wind-wave generation and propagation model
WGB	Working Group “B” (CTBT)
WMO	World Meteorological Organization
WWW	World Weather Watch
XMU	Extended Memory Unit
Y2K	Year 2000