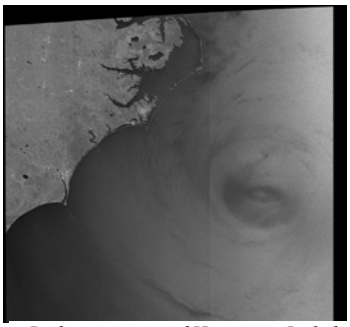
Weather

Weather information is critical to Canada and the world. Storm and disaster prediction reports save thousands of lives, and accurate weather forecasts could save billions of dollars around the world annually. In the US, the National Weather Service estimates that weather forecasting saves airlines about $US 500 million a year: avoiding a cancellation saves $40,000, and avoiding a diversion saves $150,000 for example. "It is now estimated that between two and four trillion dollars of the U.S. economy is sensitive to weather and climate. A sound and continually improving prediction capability is essential to the efficiency of those weather and climate sensitive sectors."[1]

According to the Coalition for Academic Scientific Computation, each year thousands of Americans are injured, die or suffer serious financial losses from catastrophic weather conditions such as lightning, flash floods, drought, wind storms, blizzards, hurricanes and tornadoes. When these phenomena occur with little or no advance warning, the loss of life, property and productivity is even more profound:

- Half of all airline flight delays are attributable to weather uncertainties, with wind prediction alone estimated to add over $250 million dollars to the national aviation fuel bill.
- More than half a billion dollars per year is spent preparing for predicted snowstorms that don't occur.
- The shipping industry suffers significant losses due to route changes based on inaccurate marine weather forecasts.
- Farmers sustain billions of dollars in weather-related crop losses each year. [2]



Radarsat image of Hurricane Isabel

At the recent GEO Summit in Washington D.C., organisers tried to highlight how significantly weather forecasting is linked to the economy: "An integrated Earth Observation System would vastly increase our store of knowledge and leverage billions of dollars of worldwide investment […] Better forecasting of El Nino is already saving farmers $450 millions to $550 millions a year. If weather forecasts were more accurate by just one degree Fahrenheit, the savings in electricity costs would be at least $1 billion a year […] The airline industry, which now loses about four billion dollars a year because of weather-related delays and cancellations, could cut those losses by as much as 1.7 billion dollars through better forecasting and observation."[3]

The main sectors of the Canadian economy affected by weather are agriculture, transportation, fishing, energy, construction and travel and tourism. Accurate weather forecasting can increase productivity in these areas. In one recent example, accurate forecasting of drought in the Ukraine allowed Canadian farmers to produce and sell more wheat on export markets. Better understanding and warning of extreme weather events can even save lives. Over the last ten years, direct Canadian losses attributed to extreme weather related events have been estimated at up to 11 million, including:

- $3 Billion in insurable losses
- $5-8 Billion in economic losses
  - Ice Storm 1998 - $2.5 Billion
  - Saguenay Flood - $1.2 Billion
  - Red River Floods - $400 Million
  - Calgary Hailstorms - $400 Million
  - Edmonton Tornado - $300 Million
  - B.C. Blizzard - $200 Million
- 70 - 100 lives lost
- Over 58000 people displaced[4]

"Hot" Issues:

- Air quality: Poor air quality is estimated to cause approximately 5000 premature deaths per year in Canada.
- Climate:
- Climate Change:
- Ozone Layer:
- UV Radiation:
- Water Quantity:

[1] http://www.house.gov/science/hearings/ets03/jul15/mcpherson.pdf
[2] www.ncsc.org/casc/papers/paper9.html
[3] http://www.earthobservationsummit.gov/eos_summit_clips2.pdf
[4] http://www.msc-smc.ec.gc.ca/msc/brochure_e.html

The key players:

The **Meteorological Service of Canada** (MSC), part of Environment Canada, is Canada's source for meteorological information. The Service monitors water quantities, provides information and conducts research on climate, atmospheric science, air quality, ice and other environmental issues, making it an important source of expertise in these areas. http://www.msc-smc.ec.gc.ca/msc/contents_e.html

The **World Meteorological Organisation** (WMO) has 187 Member States and is the specialized agency of the United Nations for meteorology (weather and climate), operational hydrology and related geophysical sciences. It facilitates the free and unrestricted exchange of data and information, products and services in real - or near-real time on matters relating to safety and security of society, economic well being and the prevention of the environment. http://www.wmo.ch

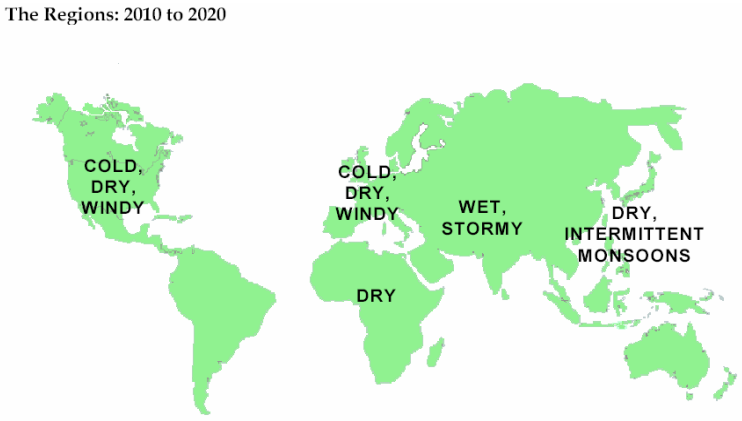
The US **National Oceanic and Atmospheric Administration** (NOAA) conducts research and gathers data about the global oceans, atmosphere, space, and sun, and applies this knowledge to science and service. NOAA warns of dangerous weather, charts seas and skies, guides the use and protection of ocean and coastal resources, and conducts research to improve the understanding and stewardship of the environment. http://www.noaa.gov

The **European Organisation for the Exploitation of Meteorological Satellites** (Eumetsat) with 18 member states and 7 cooperating states has the primary objective to establish, maintain and exploit European systems of operational meteorological satellites. EUMETSAT is responsible for the launch and operation of the satellites and for delivering satellite data to end-users as well as contributing to the operational monitoring of climate and the detection of global climate changes. http://www.eumetsat.de

Provinces: Water level and streamflow data are collected at hydrometric gauging stations across Canada, under formal cost-share agreements signed with each of the provinces and territories. These agreements with provincial governments for water monitoring have long been held as models of federal-provincial cooperation and ensure Canadians receive effective, coordinated information about water.

Universities: The Meteorological Service of Canada participates in a multitude of cooperative projects with universities and research agencies in Canada and around the world to conduct research related to atmospheric and environmental sciences and to develop policies on issues such as climate change.

Main users of weather data in Canada include:



Long-term climate changes and their impact on weather, courtesy of US Government

Department of National Defence (DND): The Canadian Forces rely on specialized meteorological and hydrological information, both on bases in Canada and during their operational missions. http://www.forces.gc.ca

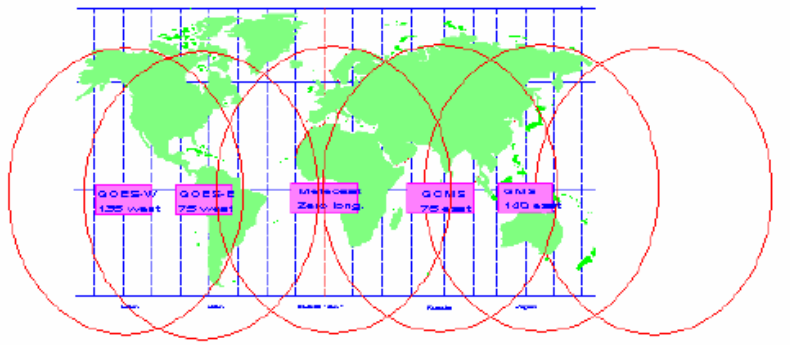
The **Canadian Coast Guard** (CCG) uses weather information to ensure the safety of mariners and the efficiency of Canada's marine transportation system. The CCG's Marine Communications system broadcasts weather and ice information to mariners at sea by radio. The Canadian Ice Service provides the CCG with specialized weather and ice information to support the activities of the icebreaker fleet as well as Search and Rescue operations. http://www.ccg-gcc.gc.ca

NAV CANADA is a private, non-share capital corporation that owns and operates Canada's civil air navigation service (ANS). Accurate and timely weather information is vital to the safety and efficiency of air transportation in Canada.
http://www.navcanada.ca

Space and Weather:

Space-based EO is a critical tool for understanding, monitoring and predicting weather. In the southern hemisphere, space is the principal source of weather information; in the northern hemisphere, terrestrial radar and in-situ networks still play a predominant role, but space in increasingly important and may hold the key to more accurate weather forecasting as new sensors become available.

Canada obtains all of its operational satellite weather data from foreign satellites. The five geostationary meteorological satellite systems currently in operation are provided by the United States (2 GEOS), Eumetsat (1 Meteosat), Russian Federation (1 GOMS), and Japan (1 GMS).



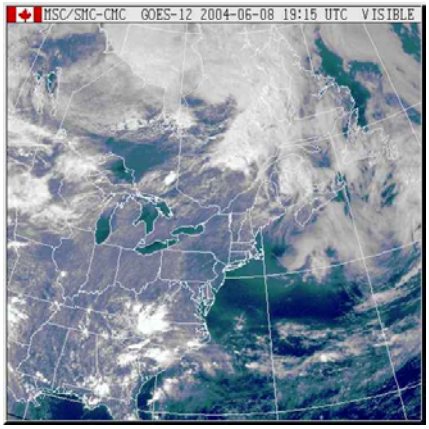
Courtesy of CGMS

The GOES satellite has two on-board imaging sensors (visible and infrared). Each sensor "sees" the same field of view; however, they differ in their sensitivity to various wavelengths of light

The light detector for each sensor is a charged-coupled device similar (in concept) to that found on most video cameras. Light energy (photons) hits the detector and generates an electrical current that can be measured with sensitive electronics.

Visible light falls in the wavelength region that can be detected by the eye, hence the term optic or optical often used to describe this region. Because the use of electronics is integral to the functioning of the detector, the visible-light detector is frequently called an electro-optical detector or sensor.

Infrared (IR) detectors can "see in the dark" by detecting the presence of "heat" given off by people and equipment. The satellite's electro-optical sensor can detect clouds visible to the eye. This sensor is sensitive to light with wavelengths from 0.4 to 1.1 micrometres (or microns; one micrometre is equal to 10-6 metre or 1/1000 of a mm). The IR sensor is sensitive to light with wavelengths from 10.5 to 12.5 micrometres. It can detect high clouds even when they are very thin and not visible to the EO sensor. This is possible because high clouds are also very cold (they are composed of ice crystals).



Eastern Canada GOES East courtesy MSC

Satellite images over Canada are generated from large data sets which are archived on a private server. There is no software in place, or any plan to implement any software, to allow the public to extract arbitrary data from the archive system. For older images NOAA's National Climate Data Center (United States), offers a fairly good historical archive on-line. Click on the "Historical GOES Browse Server" link on http://lwf.ncdc.noaa.gov/oa/satellite/satellitedata.html.

Issues for the CSA:

- Role of satellite weather monitoring and forecasting in civil space program (finding the right balance between domestic contributions and foreign data procurement);
- Use of non-weather satellites for weather purposes (and associated costs), e.g. RADARSAT for Hurricane information;
- Long-term partnership and organizational relationship to EC/MSC and to US NOAA.

Related themes:

Disasters
Environmental Factors Affecting Health
Climate and Climate Change
International Development
Sustainable Water Resources
Coastal and Marine Ecosystems
North/Arctic
Great Lakes and St. Lawrence River
Sustainable Forestry
Sustainable Agriculture
Biodiversity and Ecosystem Conservation
Security and Surveillance
University/Academia & R&D
Data policy
GEO
GMES
CEOS

References:

Basic Information:

Frequently asked questions about weather: http://weatheroffice.ec.gc.ca/mainmenu/faq_e.html#satellite1

UNISYS Weather: Satellite image details http://weather.unisys.com/satellite/details.html

Latest Update:

Meteorological Service of Canada: http://www.msc-smc.ec.gc.ca/contents_e.html

US National Oceanic and Atmospheric Administration (NOAA): http://www.noaa.gov

AccuWeather: hour-by-hour weather predictions http://wwwa.accuweather.com

A closer look:

CGMS Directory of Meteorological Satellite Applications, EUMETSAT, 1998 http://www.wmo.ch/hinsman/

World Weather Watch http://www.wmo.int/web/www/www.html

List of geostationary weather satellites, launch dates, and images of the satellites http://www.cira.colostate.edu/ramm/hillger/geo-wx.htm

Complete and exhaustive information on NOAA's Geosynchronous Operational Environmental Satellite (GOES) and Polar-Orbiting Environmental Satellite (POES) can be found from the general satellite links below. Full disk images are updated every three hours, other GOES images are updated every hour, while HPPT images are updated as they become available.
http://noaasis.noaa.gov/NOAASIS/ml/genlsatl.html
http://ww2010.atmos.uiuc.edu/(Gh)/guides/rs/home.rxml
http://ww2010.atmos.uiuc.edu/(Gh)/guides/rs/sat/img/vis.rxml
http://ww2010.atmos.uiuc.edu/(Gh)/guides/rs/sat/img/ir.rxml
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http://ww2010.atmos.uiuc.edu/(Gh)/guides/rs/sat/img/cir.rxml
Images north of 60º: http://meteo.ec.gc.ca/satellite/index_e.html, towards the end of the page.