



It is with great pride that I introduce the Second Annual RADARSAT Review of what is truly a Canadian and global success story. Since its launch in November 1995, RADARSAT has brought this country to the forefront in Earth observation, delivering valuable data to a growing list of clients in industry, governments, universities and research organizations the world over.

Through the proficient marketing efforts by RADARSAT International (RSI) of Richmond, British Columbia, commercial sales of RADARSAT data continue to grow both in terms of the amount of revenues being generated and the number of users worldwide. Under the expertise of the Canada Centre for Remote Sensing (CCRS), the technology is being applied quicker, at lower costs and in more areas. And under the direction of Satellite Operations at the Canadian Space Agency (CSA), the satellite is producing results that are being recognized and sought internationally.

As an integral part of the Space Operations Sector of the CSA, the RADARSAT program supports the Agency's overall commitment to lead the development and application of space knowledge for the benefit of Canadians and humanity. The achievements of the past two years of RADARSAT operations exemplify this commitment to advancing cost-effective, state-of-the-art space technologies. Furthermore, they solidify the foundation upon which a successor, RADARSAT II, will be built—a project that represents a key milestone in the transition of Earth observation programs from government to the private sector in Canada.

As you read this Second Annual RADARSAT Review, you will see how RADARSAT is being put to work—managing our natural resources, monitoring our environment, assisting in disaster mitigation, promoting value-added products and services, and setting standards in the knowledge-based industry. You will also understand why this Canadian-made space technology has become one of the world's greatest assets in the field of remote sensing.

Message from
W . M. (Mac) Evans
President,
Canadian Space Agency

YEAR 2 BRINGS OUTSTANDING RESULTS

After two years of successful operation, RADARSAT is performing better than ever. This past year was highlighted by unprecedented accomplishments from the first complete coverage of the Antarctic and the Earth's landmass to the continued superb performance of the satellite and its operators.

RADARSAT has supplied what 13 other satellites could not—coverage of the whole of Antarctica. Data from the Antarctic Mapping Mission is helping scientists around the world to better understand and protect this environmentally-sensitive resource which houses 70 percent of the world's fresh water. The mission also yielded a technological first for any Earth observation satellite: the flawless rotation of RADARSAT from its normal right-looking orientation to a left-looking orientation, and the subsequent return to its original position.

The Background Mission also achieved a key milestone: complete coverage of the world's continents, continental shelves and polar caps in just 20 months into RADARSAT's program. The resulting unique archive of ScanSAR imagery offers RADARSAT users unparalleled opportunities to obtain images of any landmass in the world, eliminating the need to program or reserve time on the satellite.

Message from
Rolf Mamen

Director General,
Space Operations

Within the last two years, the range of RADARSAT-based products and applications has expanded thanks in large part to the demonstrated success of application and product development projects jointly undertaken by CSA and its program partners. Products such as digital elevation models, mosaics, orthorectified imagery and optical/radar merged data sets are used to plan wireless telecommunications, search for oil and gas, create new maps, route ships, monitor floods, and update forest inventories.

Unmatched flexibility, fast data delivery, and proven reliability are hallmarks of the RADARSAT system. Capable of acquiring large volumes of data, RADARSAT is saving clients time, money and resources as a practical tool for use in strategic and tactical support in emergency situations and routine operations alike. These powerful capabilities, coupled with RADARSAT's growing network of distributors and receiving stations, translate into an outstanding competence in satisfying the information needs of hundreds of organizations worldwide.

The RADARSAT program represents an impressive feat of international, national and provincial government and private industry collaboration, ensuring that Canada and the world fully exploit the satellite's many features. Building on this partnership, the RADARSAT program offers Canadians leading-edge opportunities in creating new high technology jobs, generating revenues, developing a vibrant value-added industry, and exporting Canadian expertise and services



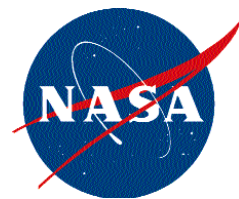
The RADARSAT program exemplifies how domestic and international partnerships benefit Canadians and the world. Industry, government and the scientific community in Canada and abroad have contributed funding, expertise and human resources to build, launch, operate and commercialize RADARSAT, the world's most advanced operationally-oriented synthetic aperture radar (SAR) satellite.

Designed and built in Canada by a team of 30 companies from across the country, RADARSAT is owned and operated by the Canadian Space Agency (CSA). From its headquarters in Saint-Hubert, Québec, Canada, CSA controls the satellite in orbit and manages its ground systems. CSA also funds various programs to promote RADARSAT data for use in commercial and scientific applications.

The Canada Centre for Remote Sensing (CCRS), part of Natural Resources Canada, operates the two RADARSAT receiving stations located in Gatineau, Québec and Prince Albert, Saskatchewan. CCRS oversees the reception, recording and archiving of RADARSAT data, and conducts applications research. Based in Ottawa, Ontario, CCRS is highly respected for its 25-year history of achievements in remote sensing.

The provinces of Québec, Ontario, British Columbia and Saskatchewan contributed funding for RADARSAT's construction. Alberta, Manitoba, New Brunswick, Nova Scotia and Prince Edward Island have pre-purchased data.

A world leader in providing information solutions from space, RADARSAT International (RSI) processes, markets and distributes the RADARSAT data. Based in Richmond, British Columbia, RSI works closely with CSA in signing up international network stations and participating with CSA and CCRS in applications development and user education programs. RSI's consortium of investors includes Spar Aerospace Limited, MacDonald Dettwiler and Associates Limited, COM DEV Limited, and Lockheed Martin Astronautics—all leaders in space technology. As part of a bilateral program, RADARSAT was launched by the United States, through the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA), in return for data and two mapping missions over Antarctica.



RADARSAT
INTERNATIONAL

The RADARSAT Program in all its aspects is being managed by the Satellite Operations Directorate of the Canadian Space Agency. Dr. Edward Langham, Director of Satellite Operations noted that the operational success of RADARSAT around the world has been largely due to the team approach among the program partners.

ANTARCTIC MAPPING MISSION: A RESOUNDING SUCCESS

The Antarctic 1 Mapping Mission (AMM) embodies the best of RADARSAT: advanced viewing capabilities, high standards of operational performance, international partnerships, and furthering our understanding of the Earth.

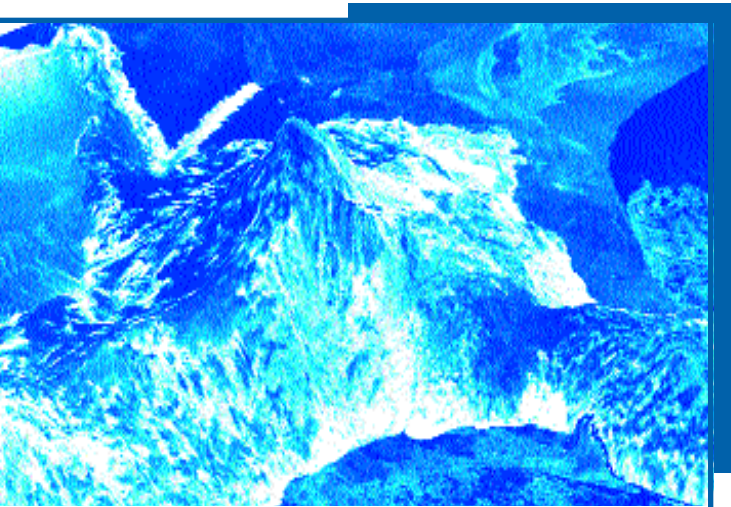
The AMM's singular accomplishment in providing the first, high resolution, snapshot radar coverage of the entire Antarctic continent is without precedent. The first mapping of Antarctica by RADARSAT is now complete, and it has been a resounding success, far exceeding my expectations both in completeness of coverage and in quality and information content of the images, said Dr. Robert Thomas, NASA's Space Program Manager for Polar Research.

The AMM also represents a technological first in the execution of the yaw manoeuvre of an Earth observation spacecraft. Starting on September 9, 1997, the three-day manoeuvre re-oriented the satellite 180 degrees from its usual right-looking mode to a left-looking mode, allowing RADARSAT to image to the left of the satellite track and cover the South Pole.

The entry manoeuvre and commissioning activities were successfully executed in less time than envisioned, enabling CSA to extend the imaging activities. As a result, RADARSAT acquired a total of 8,000 Standard and Extended High beam mode images—2,000 more than originally planned. During this period, routine commercial operations also continued.

Significant use of the onboard tape recorder was made during the mission. During peak periods, an average of 12 playbacks were made each day, an exceptional 400 percent increase over the usual three to four playbacks per day. The additional playbacks were downlinked to the Alaska SAR Facility (ASF) in Fairbanks, Alaska and the McMurdo Ground Station in Antarctica.

With the completion of the interferometric acquisitions for the Background Mission on October 20, 1997, CSA returned the satellite to its normal right-looking imaging mode. Routine



To create this 3D perspective of Ross Island in Antarctica, RADARSAT Extended High 4 data was draped over a DEM and false coloured. With its 3,794 metre elevation, Mount Erebus is clearly visible. The McMurdo Ground Station is located at the top of the island's peninsula, left of the Erebus glacial tongue that extends into McMurdo Sound. The tip of the Ross Ice Shelf is to the left of the island.

RADARSAT data © Canadian Space Agency 1997. Received and processed by the Alaska SAR Facility. Perspective prepared by the Byrd Polar Research Center of Ohio State University. Project sponsored by NASA.

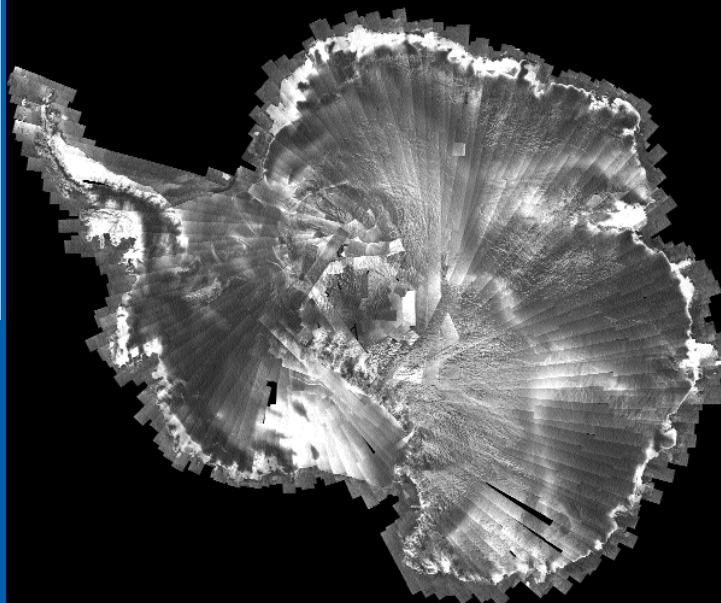


operations subsequently resumed on October 29, 1997 five full days ahead of schedule.

Governments and scientists worldwide will use this unique data set in managing and protecting Antarctica in accordance with the Antarctic Treaty System. Changes in this enormous reservoir of fresh water directly influence world sea levels and global climate. The data will help in examining, for the first time, the effects of climatological, glaciological, geological, and human activity processes on the Antarctic. The invaluable radar image of Earth's geographic South Pole from RADARSAT shows an unexpected complex structure over what was previously believed to be the nearly featureless East Antarctic Ice Sheet, said Dr. Kenneth Jezek, Director of the Byrd Polar Research Center at Ohio State University. ASF and the U.S. National Snow and Ice Data Center will distribute the final products to the American science community while RSI will offer the data to commercial clients.

With the data processing completed by ASF, scientists at the Byrd Polar Research Center are now constructing a high resolution digital mosaic of the ice sheet and the exposed portions of the continent. To be completed by September 1999, the mosaic will reveal a new level of detail on the surface form and features of the ice sheet. Moreover, it will supply a significant amount of data to help scientists understand the impact of any Antarctic changes on global climate change, according to Dr. Robert Price, Director, Mission to Planet Earth Program Office at NASA Goddard Space Flight Center.

The AMM fulfills a commitment negotiated by the CSA with NASA and NOAA. In return for launching RADARSAT in 1995, Canada agreed to execute twice the yaw manoeuvre to map Antarctica in RADARSAT's five-year mission and provide the United States with SAR on-time. A multi-partner project, AMM participants included CSA, NASA, NOAA, CCRS, RSI, Jet Propulsion Laboratory, Byrd Polar Research Center of Ohio State University, ASF, and Vexcel Corporation.



This high resolution RADARSAT mosaic of Antarctica reveals, for the first time, the existence of the East Antarctic ice streams enormous rivers of ice draining east to west into the Filchner Ronne Ice Shelf. This new view also shows the margin of the ice sheet, providing a critical benchmark for gauging climate change in Antarctica.

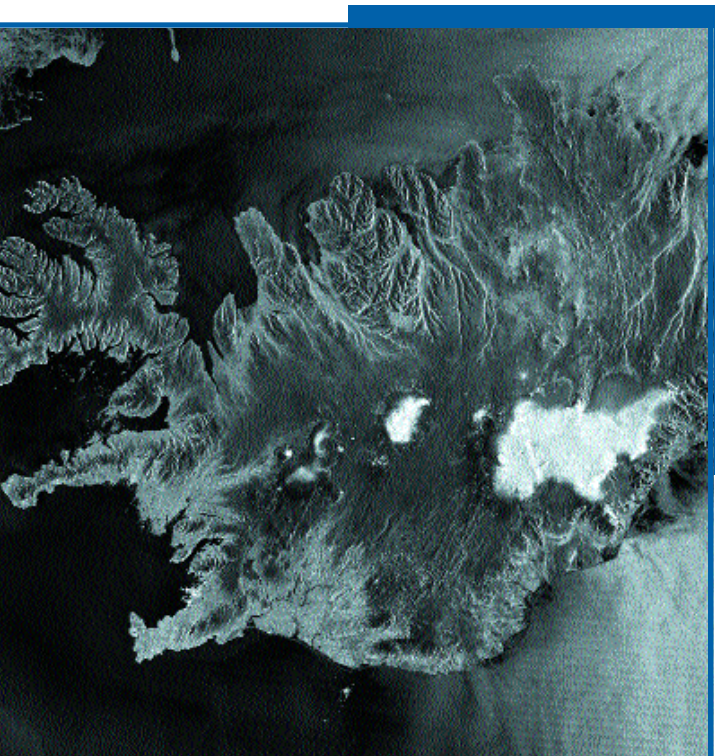
RADARSAT data © Canadian Space Agency 1997. Received and processed by the Alaska SAR Facility. Mosaic prepared by the Byrd Polar Research Center of Ohio State University. Project sponsored by NASA.



RADARSAT BACKGROUND MISSION: A YEAR OF FIRSTS

RADARSAT's ScanSAR beam mode covers areas as large as 500 x 500 km for synoptic or regional overviews. The whole of Iceland is captured in this single ScanSAR Wide image. The capital city Reykjavik (bottom left), the Mid-Atlantic Ridge (right half of image), Mt. Hekla (bottom centre), and the Vatnajökull Ice Cap (right centre) are

RADARSAT data © Canadian Space Agency 1997. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International. Enhanced by the Canadian Space Agency.



The RADARSAT Background Mission continues to achieve some exciting firsts. Just 20 months into its program, RADARSAT has provided the first complete SAR coverage of the world's continents, continental shelves and polar caps in various seasons. As well, some islands and their surrounding oceanographic features have been imaged for the first time.

This unrivalled accomplishment is supplying a vast bank of data early in RADARSAT's lifetime, and is the first step in creating an archive of global multi-mode and multi-season SAR data for use in demonstrating RADARSAT's scientific and commercial applications. Initiated in 1996, the Background Mission utilizes RADARSAT's SAR imaging time after data requests from customers have been met.

No other satellite offers the coverage of RADARSAT's ScanSAR beam mode. With its 500 kilometre wide swath and 100 metre resolution, ScanSAR Wide B beam mode was selected to establish the archive because it could quickly obtain complete coverage of the Earth. Moreover, ScanSAR provides a good contrast of terrestrial vegetation and surface phenomena.

Coverage of the world's landmass was achieved by down-linking the ScanSAR data in real time to ground facilities in Canada, the United States, Norway, the United Kingdom, and Singapore, and by using the onboard tape recorder where such facilities were unavailable. For the sake of uniformity, only RADARSAT's descending pass was used. Also, a minimum of 15 to 20 percent overlap between adjacent passes was generally maintained.

The Background Mission is also supplying a global stereo data set of the world's landmass in a unique way: by using two different incident angles through two imaging beams. To date, nearly 75 percent of North America and Western Europe has been covered with Standard beam modes 7 and 2 for stereo-pairing. When these beam pairs are combined, they provide the convergent angles suitable for mapping a wide range of terrain conditions. Cartographers and value-added companies alike are finding this data set useful in pro-



ducing maps, digital map products and digital elevation models (DEMs).

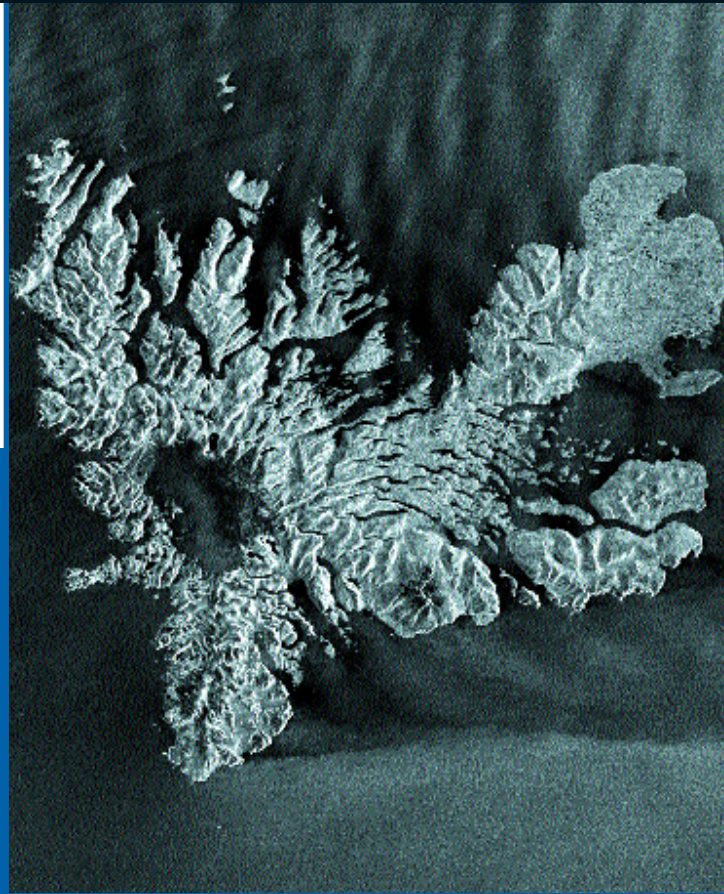
To take advantage of the viewing opportunities that the AMM presented, a supplemental Background Mission was implemented to image geological structures and other ground targets from a direction exactly opposite to the one obtained in the normal right-looking mode of operations. Regions from around the world, excluding the Antarctic, were selected based on their importance for geoscience applications, and the availability of resources after the fulfilment of the AMM requirements.

Standard 4 beam mode was used to minimize the layover and excessive shadowing in these areas of pronounced topographic relief. Using the same beam, the regions were revisited after RADARSAT was returned to its normal right-looking imaging mode. The two exact opposite look direction data sets can now be examined for textural enhancement of ground targets.

In addition, interferometric data was collected of over 50 percent of the Antarctic continent. Collecting such a large amount of this type of data was made possible by an early start of the AMM and extending the imaging period beyond RADARSAT's 24-day repeat cycle. This data will provide valuable information on relief features and on the movement of the ice sheet.

Current Background Mission activities are as follows:

- Data collection is under way using beam pairs and ascending and descending passes for both same- and opposite-side stereo views of high relief regions, and opposite-side stereo views of low relief regions of the South American continent.
- Standard 5 beam mode coverage of the world's oceanic islands is 60 percent completed.
- ScanSAR (Narrow B) coverage of North America is being acquired with real-time downlink to the three North American data reception facilities.



Using its onboard tape recorder (OBR), RADARSAT can store images when ground receiving facilities are unavailable or non-existent. This image of Kerguelen Island, located in the southern Indian Ocean, was acquired using the OBR. With its Cook Icefield, the island is an ideal place for climate monitoring. When compared to other maps and published estimates, the icefield margins highlighted in this image indicate an ice area loss of nearly 20 percent since the early 1970s.

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RADARSAT OPERATIONS: YEAR 2

The Satellite Operations Directorate communicates with the growing world-wide network of RADARSAT receiving stations to ensure client requests are

RADARSAT has fulfilled more than 18,000 requests for acquisitions in its second full year in operation, for a total of 30,250 since April 1996. An estimated 68,000 minutes of data in over 12,500 orbits has been acquired since RADARSAT's November 1995 launch.

At the heart of these exciting milestones is the Mission Management Office (MMO) operated by CSA's Satellite Operations Directorate. Based in CSA headquarters (Saint-Hubert, Qu bec, Canada), the MMO oversees the day-to-day operations of the RADARSAT system. It also maintains close communications with RADARSAT's two Canadian and a growing number of international receiving stations and five order desks, and monitors and maintains image quality and standards of the Canadian Data Processing Facility and other network processors. In addition, the MMO implements data policy and manages the expansion of the system to meet evolving client requirements.

Staffed seven days a week, the MMO accepts non-conflicting planning requests as late as 53 hours before acquisition, and offers a last minute emergency request service for qualified acquisitions. This means requests can be accepted for planning up to 22 hours before acquisition by the satellite. Average System Performance (ASP) is 95 percent, maintaining the service level from last year. The ASP is the percentage of planned requests successfully executed by the satellite and received at the ground station.

RADARSAT's onboard tape recorder (OBR) plays a critical role in satisfying user requests for data (RADARSAT is equipped with two OBRs, however, only one is used at a time.) In fact, the OBR is routinely used for playbacks up to four times a day, and during the AMM an average of 12 playbacks were made each day during peak periods. To ensure both OBRs remain in good working order, the recorders are switched every six months. Responding to an estimated 520 imaging requests each month, the OBR acquires an average of 17 images every day.

RADARSAT's Standard (S1 to S7) beam modes, Wide (W1 to W3) beam modes, Fine beam modes including 10 shifted Fine (F1N to F5F) beam modes and the Extended Low 1 (EL1) beam mode were calibrated before the AMM. None of RADARSAT's beams has ever drifted out of calibration, even after the AMM





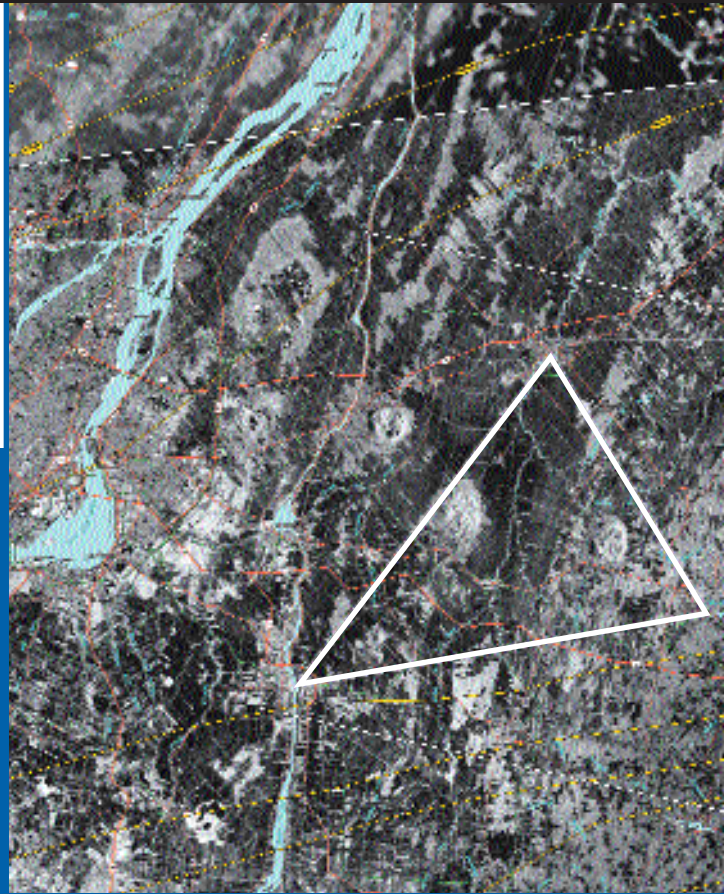
a notable stability of the SAR instrument in light of the satellite's two rotations.

Improvements to the MMO Data Base Management planning system, the swath planner, and the order desk system have increased the efficiency and ease by which data acquisitions can be ordered and planned. For example, ground track drift plots are now provided weekly to aid in planning interferometric data sets, and a duplicate database has been added, resulting in better access by the order desks for tracking orders and conducting catalogue searches.

The satellite control team of the Satellite Operations Directorate undertook extensive preparations, including simulations and rehearsals, to ensure the successful conduct of the AMM. Tests of the failed S-band transmitter and the failed horizon scanner demonstrated their suitability as backup units in case the prime units failed during the critical Antarctic re-orientation manoeuvres. A new version of the attitude control software was activated to improve the satellite's general availability and prepare RADARSAT for the AMM. This effort was clearly successful as the most recent outage, which occurred near the end of the AMM, lasted only 17 hours. Consequently, the AMM re-orientation manoeuvres were executed successfully and on time.

In early 1998, an ice storm cut off the electrical power to CSA headquarters. Although backup generators ensured that communications with RADARSAT remained uninterrupted, improvements to the in-house power system will be implemented in 1998. Modifications are also being made to the overall operational system in readiness for the year 2000, and extensive end-to-end tests are planned for late next year.

Data receiving and handling enhancements are being made at the two Canadian receiving stations, located in Gatineau, Québec and Prince Albert, Saskatchewan. For example, CSA's satellite control team and the CRS are investigating the use of a wide area network to transmit raw RADARSAT data from Prince Albert to Gatineau, which will boost the volume and speed at which data is transmitted between the two stations. In addition, upgrades to the archiving subsystems have been implemented at both stations. Outside of Canada, the ASF catalogued 53,328 RADARSAT frames, mostly from the Standard and ScanSAR beam modes. From these, ASF delivered data products to NOAA, NASA and other clients on applications



A disastrous ice storm struck Eastern Canada in early 1998. Three RADARSAT images were used to create this image product of the Montréal, Québec area: a Fine image acquired on January 20th centres on the St-Hyacinthe - Granby - St-Jean-sur-Richelieu region; a Standard image acquired on January 19th shows the southern half of Montréal and Montérégie; and a ScanSAR image acquired on January 6th covers the other two areas. The storm's impact shows up as light grey tones in hard-

RADARSAT data © Canadian Space Agency 1998. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International. Prepared by the Service des technologies - référence spatiale, Direction des relevés, Ministère des Ressources naturelles, Gouvernement du Québec.

RADARSAT APPLICATIONS DEVELOPMENT PROGRAMS

This is a Fine beam mode composite of Carman, Manitoba. Field variability can be easily detected in some of the agricultural fields. To the right, the terrain becomes more rolling with smaller fields and larger areas of trees.

RADARSAT data © Canadian Space Agency 1997. Received by the Canada Centre for Remote Sensing (CCRS). Processed and distributed by RADARSAT International. Provided by CCRS.

For over 25 years, CCRS has been providing remote sensing expertise and resources to Canadian and international organizations. As an integral partner in the RADARSAT program, CCRS investigates potential applications and manages the implementation of the following CSA-funded programs.

USER EDUCATION AND TRAINING INITIATIVE (UETI)

Thanks to UETI, Canadian industry is marketing educational and training Earth observation materials and services that are helping users develop the necessary skills to use RADARSAT data.

Seven projects were completed in 1997, bringing the total to 34 since the program was formed in 1995. Projects now under way cover curriculum and workshop development, lesson plan design, imagery interpretation, remote sensing workstation courseware and distance learning programs.

Provincial academic organizations are interested in providing products that will enhance the ability of educators to incorporate Earth observation within existing curricula. Partnerships between curriculum specialists, subject area specialists, and between educational institutions and the value-added industry are encouraged in the areas of curriculum design, multimedia authoring, and publishing.

EARTH OBSERVATION PILOT PROJECTS PROGRAM (EOP3)

Under this program, the operational use of Earth observation data, especially from RADARSAT, is developed and promoted as an effective tool for resource management and environmental protection. With an emphasis on technology transfer, EOP3 supports projects customizing existing products or services for new markets, and projects introducing new products and services. The derived information must be integrated as part of an



end-to-end operational system.

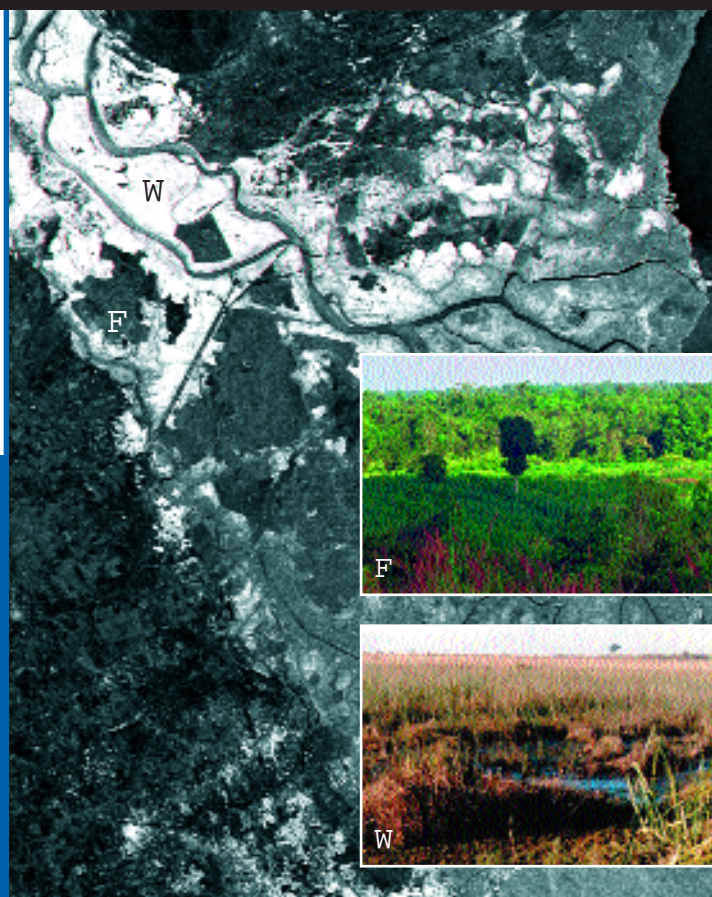
In 1997, 12 EOP3-funded projects were completed. These covered a diverse range of applications including emergency flood response, coastal mapping, mineral exploration, forest inventory, petroleum development, and navigation in ice-infested waters. RADARSAT imagery was used in eight projects, often in combination with other Earth observation satellite data. Virtually all of the projects have been successful in meeting their technical objectives, and many have led to new business opportunities for the companies involved. Of the nine ongoing projects, seven are utilizing RADARSAT data. Applications include vegetation classification, sea ice and iceberg tracking, land use monitoring, topographic mapping, forestry updating, and algal bloom detection.

In late 1997, a Request for Proposal was issued to industry to propose new projects, and 19 companies from across Canada responded. Proposed projects are in Canada, Asia, South America, and the United States, with government agencies, private sector firms and one First Nations organization as clients. Funding will be decided in early 1998.

EARTH OBSERVATION DATA SETS PROGRAM (EODS)

Established in 1996, the EODS program supplies RADARSAT and other Earth observation data to Canadian researchers who are developing applications-oriented products and information extraction algorithms. The data is used to generate information on surface biophysical and geophysical features, primarily of Canada's landmass and coastal zone. Of the 21 proposals received, 13 are active, two are completed, and six are being evaluated. RADARSAT-related projects include monitoring land use change, developing algorithms for data integration, monitoring wetland hydrology, developing quantitative tools for forest mapping, delineating anthropological sites, and developing algorithms for large-scale mosaiking.

A recent addition to EODS is its scholarship program. To date, three applications focusing on graduate work in oceanography at Canadian universities have been received. These will be



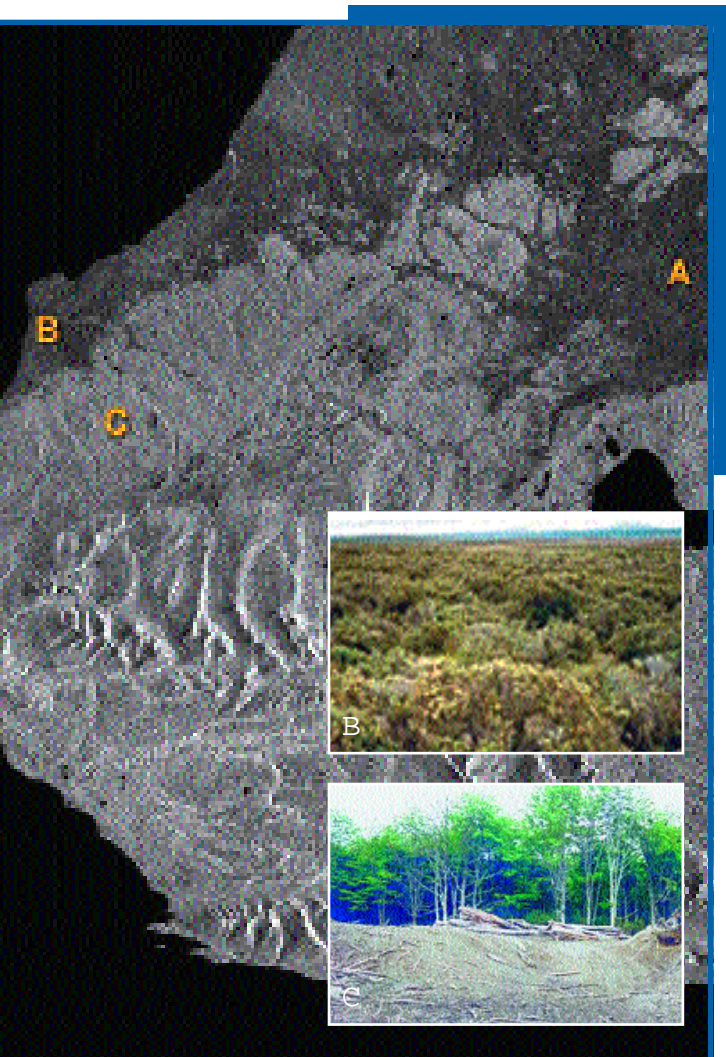
This RADARSAT image of part of the Parana River Delta in Argentina was acquired using Standard 1 beam mode. Note that the forest plantations (F) are easily distinguished from the natural wetland vegetation (W).

RADARSAT data © Canadian Space Agency 1997. Received by the Canada Centre for Remote Sensing (CCRS). Processed and distributed by RADARSAT International. Provided by CCRS.

RADARSAT APPLICATIONS DEVELOPMENT PROGRAMS

This Standard 5 beam mode image of Tierra Del Fuego, Chile is being used in monitoring vegetation change and managing forest activities. Very short prairie grasslands (A) cover most of the area. Short shrubs and bushes (B) appear lighter in tone than the grasses. The lower portions of the image are forest

RADARSAT data © Canadian Space Agency 1997. Received by the Canada Centre for Remote Sensing (CCRS). Processed and distributed by RADARSAT International. Provided by CCRS.



reviewed in cooperation with the Alliance for Marine Remote Sensing and co-sponsors in the Canadian Coast Guard and Canada's Department of Fisheries.

GLOBESAR 2

A three-year training and technology transfer project, GlobesAR 2 is developing radar expertise in 11 Latin American countries. Participating countries include Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Honduras, Panama, Peru, Uruguay, and Venezuela. CCRS-managed, GlobesAR 2 is funded by the Canadian International Development Agency (CIDA) and the International Development Research Centre (IDRC).

By the end of 1997, 148 RADARSAT images were acquired and delivered to participating countries. Processing, interpretation and results reporting are ongoing. National seminars provide opportunities to meet and exchange information; radar and technical workshops enhance the expertise of participating countries.

The Mid-Term GlobesAR 2 Symposium will be held in Cartagena, Colombia, April 20 - 24, 1998. It will be hosted by IGAC (Instituto Geografico Augustin Codazzi), the Colombian coordinating institution. Themes for the technical program include agriculture, forestry, hydrology, geology, ice, oceans, and mapping.

An invitation to participate in the GlobesAR 2 University Program was recently sent to all universities in Canada and in those GlobesAR countries that expressed interest. This program of joint research and exchange will begin in 1998.

CANADIAN EARTH OBSERVATION NETWORK (CEONET)

Developed by CCRS in 1997, CEONet is a clearinghouse for Canadian and international suppliers of geospatial data and related services, including providers of RADARSAT data and value-added products. Moreover, users anywhere in the world can now access the CEONet Web site to search the



KEY RADARSAT APPLICATIONS

New applications help drive the use of RADARSAT data. Scientists at CCRS continue to develop and demonstrate new applications of RADARSAT imagery, and the table below highlights just some of the areas that they have investigated through the previously described programs and other CCRS initiatives.

APPLICATION	ROLE OF RADARSAT
Agriculture and land cover monitoring	Measure soil moisture Assess crop conditions Update land cover maps
Forestry (Boreal and Tropical)	Detect clear cuts Update forest inventories Map depletions Map forest fires Assess regeneration Monitor land use changes
Geology	Detect structural and lithologic features Assess geohazards (landslides) Extract geomorphological information
Hydrology	Measure flood extent Improve hydrological modelling Assess flood damage
Coastal zones and oceans	Detect and track vessels Detect wind and wave spectra Detect mesoscale ocean features Monitor coastline changes
Cartography and land use	Update topologic maps Create digital elevation models Create land use and land cover maps

RADARSAT

Quickly Responds to Emergencies

The RADARSAT operations team handles emergency requests for imagery nearly every week.

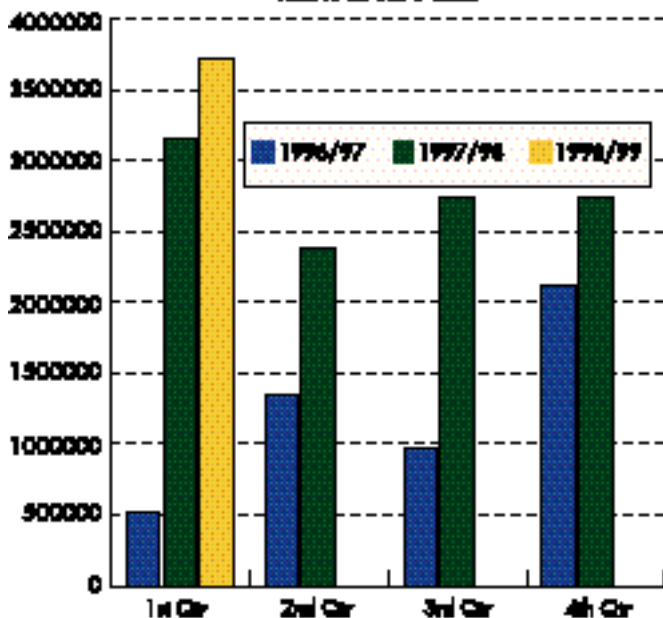
The flooding of the Red River is a good example of how RADARSAT provided useful data in an emergency situation. In the spring of 1997, Manitoba residents faced one of the worst floods in Canadian history. CSA, CCRS, RSI and companies specializing in the interpretation of RADARSAT imagery responded quickly and supplied provincial government and military officials with strategic and tactical information. Typically, RADARSAT data products were processed in near-real time (within two to four hours) to meet the requirements for up-to-date details on the advancing waters.

RADARSAT went beyond showing the extent of the devastating floodwaters. Its images and derived information products assisted authorities in the overall flood management operation, assessing existing flood mitigation measures and in developing new mitigation measures to minimize the impact of future floods.

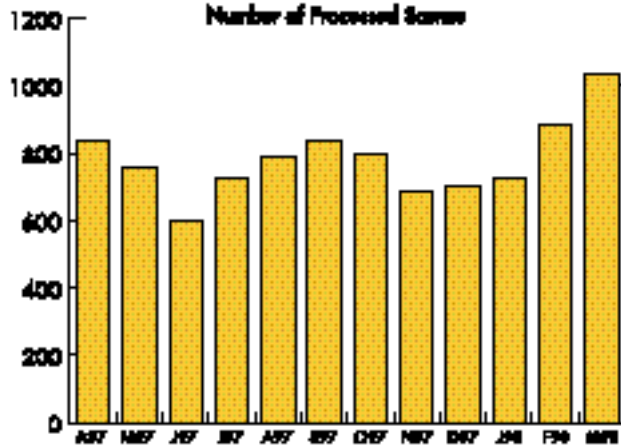
Because the flood began in the United States, the Federal Emergency Management Administration and the U.S. Army Corps of Engineers also acquired RADARSAT imagery to monitor the flood's progress from North Dakota into Manitoba. CSA has joined with CCRS and RSI to make available a CD-ROM that chronicles the 1997 Red River Valley flood and the critical role RADARSAT played in monitoring and responding to the disaster. See back cover for contact information.

ACHIEVING COMMERCIAL SUCCESS

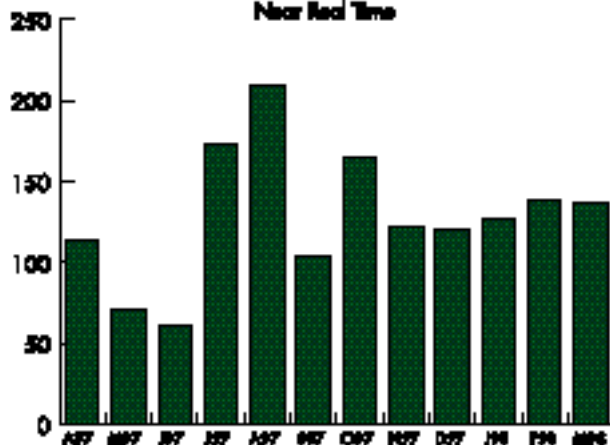
Total RADARSAT Sales



Number of Processed Scenes



Near Real Time



Since its launch in November 1995, RADARSAT continues to attract commercial clients from around the world. RADARSAT International (RSI), the Canadian company licensed by CSA to process, market and distribute data from RADARSAT, has now signed up 55 distributors in 41 countries who deliver data products to nearly 400 users worldwide.

Complementing this capable team of distributors is a network of international ground stations that ensures fast delivery of RADARSAT products and maintains high standards of data quality. At present, stations in Australia, China, Japan, Norway, Singapore, and the United Kingdom have signed agreements with RSI and CSA to receive RADARSAT data. Agreements with several other stations have also been concluded, and others are under development.

RADARSAT sales increased by 123 percent in 1997 over the previous year. Sales in the first quarter of 1998 also show signs of continued strong growth. RSI is achieving an outstanding 99 percent success rate in satisfying a client's first choice of acquisitions. RSI pays royalties to CSA on sales of RADARSAT data. RSI has also paid \$10 million to acquire the Canadian Data Processing Facility (Gatineau, Quebec), and \$1 million to upgrade its processor in Richmond, British Columbia.

The RSI-managed Canadian Data Processing Facility processed approximately 9,374 scenes and delivered 1,540 products in near-real time from April 1, 1997 to March 31, 1998. Responding to client needs, RSI is using the Internet to improve access to the RADARSAT archive and to deliver more and more data products. In addition, RSI continues to introduce new products and services including RADARMap products, large area mosaics, an emergency response subscription service, and per km² pricing for large area coverage, monitoring services and RADARSAT-derived DEMs.

As part of its mandate to educate the international user community, RSI works with CCRS, CSA and the geomatics industry to lead and sponsor radar workshops worldwide. The company publishes award-winning educational materi-

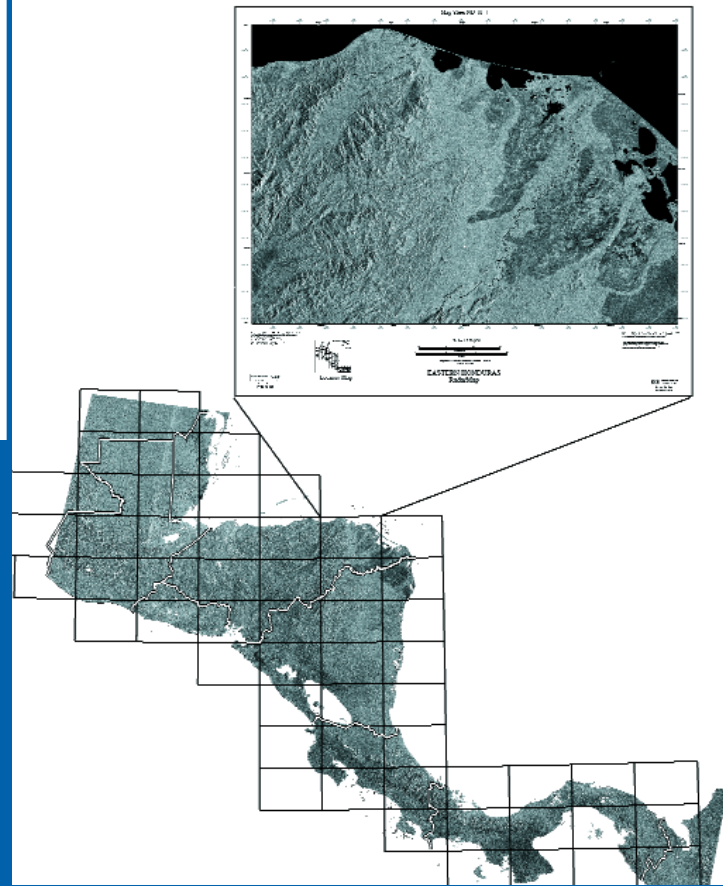


als, and has formed a global network of RADARSAT Resource Centres to supply regional support and training. Seven centres are now open in Australia, Canada, China, France, the Netherlands, Thailand, and the United States. The unique Web-based training tool, www.radarsatinaction.com, funded by UETI, RSI and Geomatics International, helps organizations worldwide adopt RADARSAT technology, and attracts more than 500 hits per day.

Leading commercial applications include geological exploration (for oil, gas, and minerals), coastal zone management, ice reconnaissance, maritime and terrestrial surveillance, disaster mitigation, land cover mapping, and agricultural monitoring. Through programs such as ADRO, RUDP, GlobeSAR and RDDP (Radar Data Development Program), RSI, in collaboration with CCRS and CSA, continue to investigate exciting new commercial applications, such as telecommunications (wireless network planning).

RSI, CSA and CCRS are forging partnerships with the Canadian and international value-added industry to meet the diverse needs of RADARSAT clients. Industry partners include Atlantis Scientific, Compusult, Devel-Tech, Imagelinks, Intermap Technologies, PCI, Resource GIS and Imaging, and Vexcel Corporation. In addition, RSI has endorsed six commercial image processing software products that read and manipulate RADARSAT data.

As a Canadian-held company, RSI has an expert staff of over 80 professionals dedicated to promoting the commercial use of RADARSAT data and generating revenues from the worldwide sales of RADARSAT products and services. Overall, RSI estimates it has captured 12 percent of the worldwide remote sensing market a remarkable early achievement which is placing Canada's RADARSAT at the vanguard of the world's Earth observation industry.



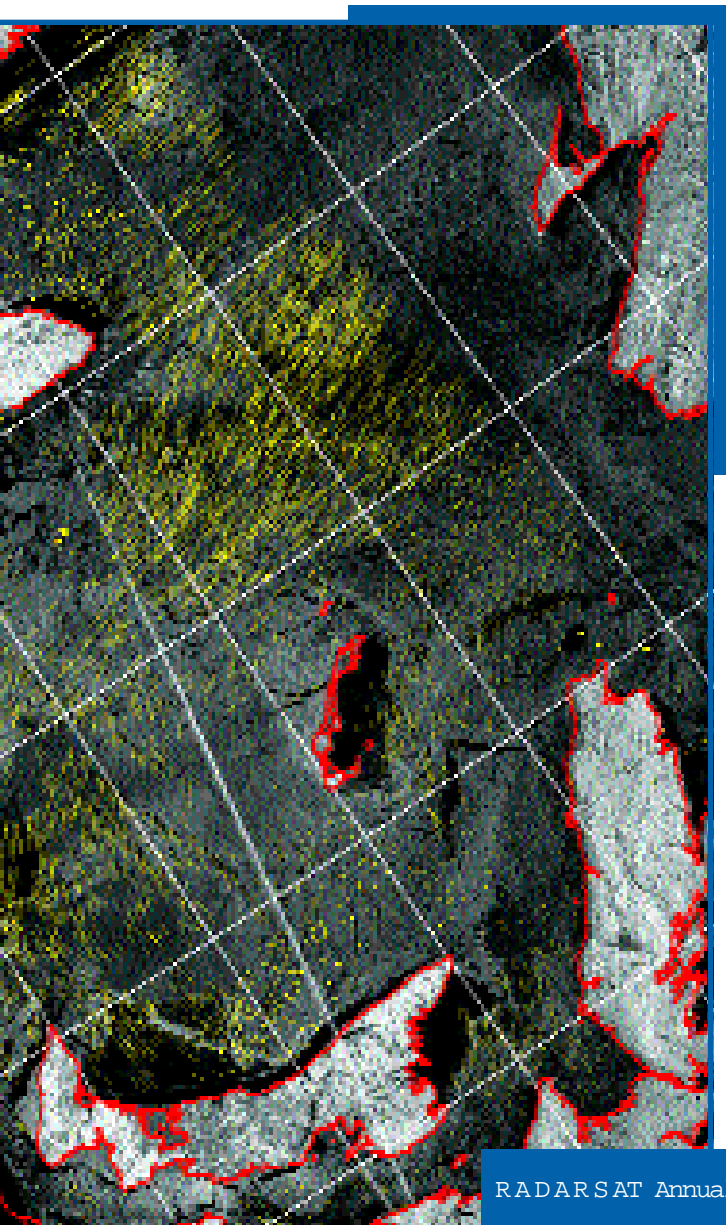
This RADARMap of Central America is a new RADARSAT product recently introduced by RADARSAT International and Resource GIS and Imaging (RGI). RADARMaps are pre-processed, cloud-free, black and white, 50 metre resolution, 1:250,000 scale indexed map sheets measuring 1 degree latitude by 1.5 degree longitude. They are available as basic or orthorectified products with standard cartographic surround.

RADARSAT data © Canadian Space Agency 1997. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International. RADARMap by RGI.



This Ice Tracker image product was generated from two RADARSAT ScanSAR Wide images acquired some 12 hours apart. The Tracker software automatically calculated the ice motion vectors (yellow) which represent the displacement of ice over the 12-hour period. These were then overlaid on the later image. This regional view of the movement of ice helps ship operators

RADARSAT data © Canadian Space Agency 1997. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International. Product generated using the ice tracking algorithm developed by Noetix Research Inc. at the Canadian Ice Service.



One of the biggest users of RADARSAT data is the Canadian Ice Service (CIS). CIS routinely delivers information on sea ice conditions in Canada's offshore areas within a matter of hours: RADARSAT data is received in real time at the Ice Centre (Ottawa, Ontario) from the Canadian Data Processing Facility via a T1 digital telecommunications link. At the Ice Centre, image products are generated and then delivered electronically onboard to ship operators often within one hour—a vital requirement to the safe routing of vessels in potentially hazardous conditions.

During 1997 alone, CIS acquired nearly 3,000 frames of RADARSAT data across the T1 link. From this data stream, CIS supplied 32,414 image products and 8,633 graphical analyses to more than 300 clients. CIS products range from ice analysis charts, imageries, daily bulletins, ice forecast charts to seasonal outlooks. As CIS's primary source of data, RADARSAT has saved CIS an estimated C\$6 – \$7 million per year in data acquisition costs.

The Canadian Coast Guard (CCG) is a major CIS client. CCG takes advantage of the broad geographic coverage and frequent revisit capabilities offered by RADARSAT's ScanSAR mode to design shipping routes and manage the deployment of icebreakers.

CIS is increasingly turning to RADARSAT's higher resolution beam modes to supply more detailed information on smaller areas. Fine, Standard and Wide beam mode data have been used in projects such as the construction of the Confederation Bridge between Prince Edward Island and New Brunswick, at a new mine site at Voisey's Bay, and to monitor oil spills off Newfoundland.

Other recent activities include the installation of an automated tracking system that calculates ice displacements, the evaluation of ice motion products, and the testing of a prototype sea ice classification system. These will enable CIS to offer a full suite of RADARSAT analysis tools to marine operators who need information quickly and reliably on ever-changing sea ice conditions.