



Canadian Space Agency
Agence spatiale
canadienne



RADARSAT



[Annual Review]



RADARSAT-1 is the Canadian Space Agency's first Earth Observation satellite. Equipped with a powerful synthetic aperture radar (SAR) instrument, the RADARSAT-1 satellite acquires images of the Earth day or night and in all weather including cloud cover, smoke and haze.

RADARSAT-1 Program Partners

Canadian Space Agency (CSA)

Space Operations, Satellite Operations Directorate

Natural Resources Canada (NRCan)

Canada Centre for Remote Sensing (CCRS)

MacDonald, Dettwiler and Associates (MDA)

RADARSAT International (RSI)

National Aeronautics and Space Administration (NASA)

National Oceanic and Atmospheric Administration (NOAA)

Canadian Provinces

Canadian Industry

International Network Stations



Contents

The Global Reach of Canadian Innovation	3
RADARSAT-1: Leading Role in International EO Community	5
Extending the Life of RADARSAT-1	6
A Global Presence	10
Disaster Management: Reaching out to the World	14
Antarctica: A New Age of Exploration	16
Data Source of Choice	18
Students on Ice	20
Total Solutions for Evolving Business Needs	22
Workshops Bolster Data Usage	24
Meeting Future Earth Observation Needs	26
RADARSAT-2: Advancing Earth Observation	30

December 12, 2001 marked the 100th anniversary of Guglielmo Marconi's historic radio broadcast from Cornwall to Signal Hill, Newfoundland, which is clearly visible in this Fine 1 image of St. John's. When Marconi heard three faint clicks on Signal Hill, he gave the world a preview of how this technology would transform how we communicate. The development of the RADARSAT-1 satellite technology carries on Canada's tradition of technology innovation, providing new and unique images of the Earth. *RADARSAT-1 data © Canadian Space Agency 2001. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International.*

Signal Hill
■



The Global Reach of Canadian Innovation

After seven years at the helm of the Canadian Space Agency (CSA), Mr. Mac Evans retired on November 22, 2001. I now have the honour of following in the footsteps of an extraordinary individual who devoted 30 years of his life to the conception and promotion of many of the space plans that define the Canadian Space Program today. We are proud of the legacy he leaves us, and in particular, the RADARSAT Program.

RADARSAT-1, the first Canadian commercial Earth Observation (EO) satellite, is the backbone of the Earth and Environment sector—one of CSA's five principal service lines—that includes space technologies used for the study, surveillance and protection of the Earth and its environment. Canadian technological and scientific achievements, as well as the Canadian expertise engendered by RADARSAT-1, have been undeniably outstanding over the past six years. Indeed, in exceeding its design life expectancy, RADARSAT-1 continues to reliably deliver SAR data products to nearly 600 clients in almost 60 countries, with applications in diverse fields ranging from cartography and agriculture to disaster monitoring and petroleum exploration.

I am committed to continuing CSA's development of advanced, state-of-the-art space technologies that will benefit Canadians. Having seen first-hand our blue planet from space also makes me realize the need to utilize our space resources for the benefit of all humanity. With that in mind, CSA has joined with other space agencies in providing EO data under the International Charter "Space and Major Disasters," and helping to mitigate the effects of catastrophes around the world.

In developing an innovative satellite SAR system, Canada has taken a leadership role in providing space-based technologies that respond to real needs here on Earth. This pioneering effort will help prepare the international community for RADARSAT-2, the next generation of Canada's EO satellite technology.

*Dr. Marc Garneau
President
Canadian Space Agency*



From its corporate headquarters in Saint-Hubert, Quebec, which houses the RADARSAT-1 Mission Control, the Canadian Space Agency is leading Canada into a new era of development and application of Canadian Earth Observation technology and resources for the benefit of all humanity. *RADARSAT-1 data © Canadian Space Agency 1999. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International.*

New Executive Team Leads CSA in 21st Century

As Canada embarks on its fifth decade in space, it does so with leadership that is both new and familiar. The recent CSA appointments of Dr. Marc Garneau as President and of Mr. Pierre Richard as Senior Vice-President build on the well-established tradition of leadership, excellence and innovation that has made Canada a leader among space-faring nations. Both Dr. Garneau and Mr. Richard draw on vast experience and distinguished careers in Canada's Public Service and military.

Dr. Garneau, who served in the Canadian Navy for 15 years, was an original member of the Canadian astronaut corps. Dr. Garneau was Canada's first astronaut to go into space, and flew on three space shuttle flights before retiring as an astronaut to take on his executive management responsibilities with CSA. Throughout his career Dr. Garneau has demonstrated a commitment to excellence and a dedication to ensuring that the development and application of Canadian space knowledge, expertise and technology benefits all Canadians and all humanity.

Mr. Richard works closely with Dr. Garneau to help shape the future direction of CSA and to continue to provide the Agency with strong leadership. Prior to his appointment as CSA's Senior Vice-President, Mr. Richard directed the strategic positioning and communications efforts of Natural Resources Canada, and held executive management roles in other federal government departments such as Health Canada, the Department of National Defence, and the Privy Council Office. He also served 13 years with the Canadian Forces, including postings both abroad and in Canada.



Mr. Pierre Richard
Senior Vice-President
Canadian Space Agency

In its seventh year of operation and two years beyond its five-year design lifetime, Canada's RADARSAT-1 satellite continues to perform on schedule, delivering unique and high-quality SAR data products to commercial, operational and scientific clients worldwide. This unfailing reliability became increasingly important in 2001 with CSA's commitment to continue to operate RADARSAT-1 at least until RADARSAT-2 is launched and commissioned.

Accordingly, CSA directed a major focus in fiscal year 2001/2002 to the preservation of the RADARSAT-1 satellite. "With their intrinsic skills perfected by years of experience in operating this powerful satellite SAR system, I'm confident our team is the best qualified anywhere to meet the challenge of successfully extending the life of RADARSAT-1 until RADARSAT-2 is commissioned," said Dr. Rolf Mamen.

"Furthermore, I'm proud to report that the RADARSAT-1 Program has not only met but surpassed all of the objectives set out in 1995," noted Dr. Mamen. "Without question, the Program has achieved unprecedented success in establishing market segments which have resulted in economic benefits to the public and private sectors, as well as in promoting the use of RADARSAT-1

Leading Role in the International EO Community

Dr. Rolf Mamen, Director General, Space Operations
Dr. Surendra Parashar, Director, Satellite Operations

data around the world, while generating a significant revenue for CSA. In addition, the Program continues to foster the science applications of SAR data and promote the national interest, as well as support and contribute to Canadian industry leadership, global environment and resource management, and to the development of a commercially viable remote sensing industry."

RADARSAT-1's extraordinary images of the icy continent of Antarctica continue to captivate the public's attention. This year was no exception: in February 2002, the National Geographic Society published a stunning thematic map supplement—based on imagery from RADARSAT-1's historic Antarctic missions of 1997 and 2000—a portion of which is featured in this year's review.

Shifting focus from the print medium to television, 2001 saw CSA enter into negotiations for a license agreement with Quebec's Télévision Quatre Saisons (TQS). Under this agreement, TQS is able to display part of the RADARSAT-1 Mosaic of Canada for its weather reports on Quebec, New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island. This unique agreement will lead to a new visibility for the RADARSAT-1 Program.

During this past year, the Province of Newfoundland and Labrador became a strategic partner in the RADARSAT-1 Program upon signing a data agreement with CSA, which completes the series of Memoranda of Understanding with Canada's provinces. A data agreement has also been initiated with the government of the Yukon. In addition, the National Master Standing Offer (NMSO) was renegotiated, enabling Canadian government department and agency users to purchase RADARSAT-1 data at a reduced price from RSI.

The past fiscal year also saw NASA and NOAA extend their agreement with CSA for the utilization of RADARSAT-1 data, for example, by the US National Ice Center, which works closely with the Canadian Ice Service. Another notable accomplishment was the successful completion of RADARSAT-1's global land stereo coverage, which makes the RADARSAT-1 archive the world's largest database for radargrammetric applications.

The role of RADARSAT-1 continues to evolve to meet emerging EO opportunities. According to Dr. Surendra Parashar, "This means that RADARSAT-1 data products are gaining more significance as a valuable component in end-to-end information solutions, as well as in complementing other data sources. Canada continues to forge strong links with other EO data providers through initiatives such as the International Charter "Space and Major Disasters." We're ready for this wider, more global role, and intend to leverage our considerable experience with RADARSAT-1 to support other satellite missions such as SCISAT, ENVISAT and, in the future, RADARSAT-2."

At the close of 2001, and more than six years after the launch of RADARSAT-1 on November 4, 1995, Canada's SAR satellite continues to acquire high-quality SAR data. In this extended mission life operation, the Operations Planning group of Satellite Operations continues to support the imagery requests of commercial, scientific and operational clients from around the world with an exceptional success rate of 96 percent.

A key achievement for the Operations Planning group was assuming the responsibility of the Canadian Government Order Desk (CGOD) in Saint-Hubert, Quebec on June 25, 2001. CGOD manages the scheduling, acquisition and production support services for all Canadian federal, provincial and territorial government RADARSAT-1 imaging requests. Previously, CCRS provided this service from Ottawa.

By accessing a CSA ftp site, Canadian government users can now order RADARSAT-1 images more efficiently, as well as more easily select data products and obtain information on the RADARSAT-1 system. This client-focused approach has meant that CGOD was able to process an impressive 426 image requests in the past six months.

Enhanced Image Processing

This past year has been productive for the Canadian Data and Processing Facility (CDPF), highlighted by the conclusion of the upgrade project. Milestones completed in 2001 encompassed the incorporation of a physical model for the Doppler Centroid Estimator, as well as the Automatic Gain Control Saturation Correction algorithm, which will improve visible quality and reduce radiometric variations within both single beam and ScanSAR images.



The Kangaroo Rat is one of 22 rodent species for which researchers at the Seville National Wildlife Refuge and Long-Term Ecological Research site maintain long-term data. Research results are being used to develop rodent/virus sampling strategies and human disease prevention plans in the United States. Photograph © Karen Kirtland, Natural Resources Assessment Inc.

Extending the Life of RADARSAT



Particularly noteworthy was the delivery and acceptance by RSI of a new MDA Direct Archive System (DAS) and a Product Generation System (PGS), which operates the RADARSAT-1 SAR processing module. Combined, the DAS/PGS systems will function as backup to the existing CDPF, following the full integration into the RADARSAT-1 ground segment.

Maintaining Image Quality

As in past years, the RADARSAT-1 image quality maintenance program continued to be fully operational throughout 2001. The radiometric calibration performance of each calibrated beam was monitored regularly and adjustments in processing parameters were made. Efforts were also focused on enhancing previously existing tools and methodologies. In addition, a new tool was developed to specify details of the location error measured on images of RADARSAT-1 precision transponders.

RADARSAT-1 Archives Search Application

Vantage Point International (VPI) is developing a RADARSAT-1 archives search application for the CSA web site. Scheduled to go online in April 2002, the application will provide web visitors with the ability to search a database for all the acquisitions made by RADARSAT-1 since its 1995 launch. Acquisitions returned by the search will be drawn as swaths on a web map, which will allow visitors to see whether or not the area they are interested in is covered.

With this new ability to see what is available in the RADARSAT-1 archives, clients who wish to purchase an archive image will be able to indicate to the Order Desk exactly what image they need, rather than first inquiring whether or not such an image exists. The online database will be updated daily, making the RADARSAT-1 archives search application a useful tool for RADARSAT-1 data users around the world.

Change detection in SAR imagery is often hindered by speckle noise, which can be reduced without loss of spatial resolution if multiple images are used. A series of six Standard 1 images were acquired over New Mexico (United States) between June and November 1999. At the top of the image is the Sevilleta National Wildlife Refuge and Long-Term Ecological Research site; the Rio Grande River is on the left. Principal Components Analysis was applied to the co-registered image series. The first principal component (PC1) image captures radiometrically persistent features in the landscape with little loss of detail due to speckle. Shown in green, PC1 serves as a baseline for identifying significant changes in backscatter. Ephemeral streams and drainage networks, which appear after rainfalls, are shown in red and blue. RADARSAT-1 data © Canadian Space Agency 1999. Received and processed by Alaska SAR Facility (ASF). Distributed by ASF and RADARSAT International. Produced and provided by CALMIT, University of Nebraska-Lincoln.

7

ARSAT-1





Extending the Life of RADARSAT-1

RADARSAT-1 System Performance

8

2001 acquisition requests	22 215
2001 estimated minutes of data	45 612
2001 orbits	5 217
2001 estimated OBR imaging requests	5 553
Average system performance	96%
Number of playbacks per day	4.8
Total estimated number of requests	119 344
Total estimated minutes of data	258 144
Total orbits	33 431
Total estimated OBR minutes	61 751
2001 emergency event requests under the International Charter "Space and Major Disasters" (21 frames obtained)	5
2001 other emergency event requests (8 frames obtained)	5

Safeguarding RADARSAT-1's Health

Since the RADARSAT-1 satellite exceeded its life expectancy in November 2000, the System Operation group of Satellite Operations has invested considerable effort to identify and protect against potential causes or impacts of system failure. They have succeeded, and all systems onboard this powerful SAR satellite continue to operate effectively. Continuity of SAR data service for customers until RADARSAT-2 is launched—through continued RADARSAT-1 operation—remains a CSA priority.

Extensive analysis undertaken in 2001 indicates that RADARSAT-1's solar array will continue to provide adequate power for normal operation for many years to come. Propellant use is considerably lower than planned, partly as an expected inclination correction now appears unnecessary. Use of other consumable on-board resources, such as switch cycles, continues at a normal rate. Since most of the redundant units remain unused, they offer a second supply of resources once the first is exhausted.

Speed control of the remaining horizon scanner continues to be a challenge. However, System Operation engineers have succeeded in reducing attitude errors in back-up control modes to levels acceptable both for satellite safety and for SAR imaging. Should the horizon scanner fail, this event is expected to have no effect on the user community. Studies and tests have also shown that if the healthy S-band downlink transmitter fails, operations can continue almost normally using the other degraded transmitter.

Lastly, the high-intensity LEONID meteor shower of November 2001 passed without detectable effect upon the satellite. As a result of this and other system achievements over the past year, the System Operation team is confident that it has taken all possible steps to maximize the life of the satellite.

Toward a Multi-Mission Future

During 2001, the Satellite Operations Directorate moved closer to providing multi-mission functionality. After successfully supporting the HELIOS-1B mission on behalf of CNES in 1999, the Directorate was requested to begin preparations to track the launch of ENVISAT on ARIANE 5 in February 2002 and later SPOT-5 on ARIANE 4 in 2002, as well as to provide LEOP support to SPOT-5. Accordingly, the telemetry, tracking, and command (TT&C) system was enhanced to ensure its compatibility with the CNES network. In return for this support, CSA can request equivalent station support during the LEOP of SCISAT-1, which will be flown from Saint-Hubert, Quebec.

As ESA's most advanced EO satellite, ENVISAT was successfully launched on February 28, 2002. ENVISAT, the follow-on to the ERS-1 and ERS-2 satellites, will supply radar data, which together with radar data from RADARSAT-1, and soon RADARSAT-2, will be used by the commercial and scientific community in Canada. *Artist version of ENVISAT courtesy of ESA.*

The SCISAT-1 Mission Operation Centre (MOC)—the key operational component of the SCISAT-1 system, began to take shape in 2001. The design was finalized, based upon the TT&C changes in readiness for the CNES missions, and key equipment ordered; system integration will take place during summer 2002. This will form the basis of the system for satellite control of future CSA missions, as well as other missions such as SAPPHERE.

The MOC will operate the SCISAT-1 satellite from launch in late 2002.



Artist version of SCISAT.



Biologists at the Canadian Wildlife Service (CWS) of Environment Canada are using RADARSAT-1 data to study ice conditions around Canada's Belcher Islands, a series of island archipelagoes in southeastern Hudson Bay. CWS biologists are tracking how rapidly ice changes—winds often drive pack ice on- and offshore, as well as analyzing the effect of changing ice conditions on the distribution and abundance of sea birds in this important marine habitat. *RADARSAT-1 data © Canadian Space Agency 1999. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International. Sea bird and researcher photographs courtesy of Canadian Wildlife Service, Environment Canada.*



Rafael Fernandez-Sein
University of Puerto Rico
(UPRM), USA



Miguel Dragomir Zaníc Cuellar
Instituto Nacional de
Pesquisas Espaciais (INPE),
Brazil



Andrew Ha
Korea Earth Observation
Centre (KEOC), Korea



Tony Bauna
Tromsø Satellite
Station (TSS), Norway



Ian Pilling
QinetiQ, UK



Chuan-rong Li
China Remote
Sensing Satellite
Ground Station (RSGS),
People's Republic of China

Shown here are just a few of the global representatives who attended the 2001 RADARSAT-1 Network Stations' Meeting, which was held at CSA headquarters in Saint-Hubert, Quebec, Canada.




In 2001, the ground stations in Thailand and Brazil achieved product certification, expanding the global coverage capabilities of the RADARSAT-1 Program and boosting the total number of RADARSAT-1 ground stations to 18. This year also marked the signing of a second station agreement in South America, and the certification of the Argentina ground station is now under way.

Ground Stations Explore New Applications

For the first time CSA's Satellite Operations Directorate and RSI hosted the RADARSAT Network Stations' Meeting at CSA headquarters in Saint-Hubert, Quebec. Representatives from nearly all of the 18 RADARSAT-1 ground stations—which together provide real-time coverage of three quarters of the world's land mass—participated in the three-day meeting in October 2001.

Ground stations in geographically diverse countries such as South Korea, Norway, Brazil, and the United Kingdom benefited from presentations aimed at their region-specific requirements.

In early 2002, CSA successfully completed RADARSAT-1 beam pair stereo coverage of the Earth's land mass. In this map, light yellow represents Standard 7 and Standard 2 / Standard 4 beam pair coverage, and dark yellow represents Standard 7 and Wide 2 beam pair coverage.

-  Standard 7 beam combined with either Standard 4 or Standard 2 beam stereo coverage
-  Standard 7 beam combined with Wide 2 beam stereo coverage
-  Non-covered area

A Global Presence

RADARSAT-1 ground receiving station in Gatineau, Quebec, Canada.



Exploring new RADARSAT-1 applications and markets that could be supported by operational ground stations dominated discussions at this interactive forum. For example, applications such as crop insurance and wind-field extraction, as well as ice monitoring and pipeline encroachment monitoring were examined. In addition, discussions of other potential applications included the integration of RADARSAT-1 with flood information projects, and marine applications. Furthermore, this year's meeting highlighted the fusion between existing technologies and RADARSAT-1 applications, as demonstrated in Over the Horizon Radar (OTHR), a system developed by Raytheon Canada in which RADARSAT-1 data was fused with OTHR data for vessel monitoring.

Background Mission Generates Global Stereo Coverage

RADARSAT-1 beam pair stereo coverage of the Earth's land mass was successfully completed in early 2002. As a result, the RADARSAT-1 archives have become the world's largest database for radargrammetric applications. Acquired over the past six years, this stereo data has been primarily used for mapping applications, including 3D viewing, digital elevation models and image rectification.

Global stereo coverage was achieved by combining Standard 7 coverage with coverage from a second beam. The second beam used a similar resolution and appropriate incidence angle difference, such as Standard 2 and 4 or Wide 2, depending upon the terrain geometry and the location of the region covered. Seasonal coherence was maintained as much as possible to ensure the quality of the stereo pairs.

Space Agencies

Together Support
Humanitarian Relief Efforts
Around the World



In response to catastrophes on four continents, the International Charter "Space and Major Disasters" was invoked eight times in 2001. These included a second wave of seismic shocks and accompanying landslides in El Salvador, flooding of the Saone River in France, oil spills off the coasts of Lebanon and Denmark, flooding of the Lena River in Siberia and the Nias Island in Indonesia, the volcanic eruption of Mount Etna in Italy, and flooding of the Moselle and Meuse Rivers in France and Germany. In all these disasters, the Charter partner agencies (ESA, CNES and CSA) successfully delivered multi-satellite data and data products to those in need—demonstrating the operational ability of these agencies to rise to the challenge of playing a coordinated role in the timely acquisition, processing, and delivery of vital information.

In 2001 the International Charter welcomed two new members: the U.S. National Oceanic and Atmospheric Administration (NOAA) and the Indian Space Research Organization (ISRO). Their respective space and ground resources will strengthen the effectiveness and coverage opportunities of the Charter in responding to disasters.

Charter Evaluation Workshops

Two Charter Evaluation Workshops were held during the past year. The workshop in October 2001 examined the operating and activation procedures with Charter project managers and the relationships with value-added companies. At the January 2002 workshop in Paris, workshop participants reviewed the Charter's achievements over the previous 14 months. This most recent session also considered the capabilities of new EO satellite systems including SPOT-5, ENVISAT, RADARSAT-2, Cosmo-Skymed/Pleiades, as well as space telecommunications services such as the pilot Project REMSAT and the CNES New Stentor Services (NSS) test project—both aimed at fire monitoring, and the extended use of the Argos system and its potential contribution to disaster management.



Charter Web Site Provides Critical Information

In addition, members of the International Charter launched an innovative website (www.disasterscharter.org) at the January 2002 workshop. All International Charter members participated in the creation of the web site, which is hosted by CSA's Satellite Operations Directorate, and includes information on Charter members, Charter activations to date, and what happens when the Charter is activated. "This web site is an important step forward in the way we provide rescue and civil defence authorities with the information they need to help teams on the ground when time is critical," said Jean-Luc Bessis on behalf of the International Charter's Executive Secretariat.

Surendra Parashar, Director, Satellite Operations added, "As host of the International Charter web site, we are proud to contribute to this collective and international action. It will enable satellite planners from the member space agencies to accelerate the immediate tasking of space-based resources including SPOT, ERS, RADARSAT-1, as well as the soon-to-be-launched Indian and US satellites, which will acquire new images to assist humanity."





The January 13, 2001 earthquake that struck southern El Salvador lasted only 43 seconds but killed more than 1 000 people and caused multiple landslides. The most devastating landslide struck Santa Tecla, a western suburb of the capital city of San Salvador, killing 585 and burying or damaging hundreds of homes. Photograph courtesy of CCRS.

Disaster Management: Rea

14

Disaster Management Action Team

Canada has assumed a key role in the activities of the Disaster Management Action Team that was created following the UNISPACE III conference of the United Nations in 1999. This and other UNISPACE III Action Teams carry out activities under the auspices of the Scientific and Technical Subcommittee of COPUOS (Committee on the Peaceful Uses of Outer Space). Twenty-five countries and international organizations have already become members and are contributing to the activities of the Disaster Management Action Team.

Canada's central role as Coordinator (along with China and France) is ensured by CSA's Satellite Operations Directorate. The Action Team held its first meeting in October 2001 during the 52nd International Astronautical Congress in Toulouse, France. The Action Team will analyze existing mechanisms and technologies, define requirements, develop solutions, and make recommendations that will lead to the implementation of an integrated global disaster management system and the utilization of the system by the various nations.

Disaster Watch 2001

Since April 2001, more than 367 images of disasters were acquired under this joint CSA/RSI program—a substantial increase from the 200 acquired last year. In addition, the Disaster Watch database continues to be updated daily with CSA's Disaster Watch Report, which is now distributed to 178 organizations and individuals



ching out to the World

On May 22, 2001, the International Charter "Space and Major Disasters" was activated following the spring flooding of the Lena River in Siberia. The city of Yakutsk and its 200 000 residents bore the brunt of the destructive floods. This multi-satellite image combines data from RADARSAT, LANDSAT and SPOT. Urban areas are shown in white, water bodies in blue, forests in green, and agricultural areas in brown. RADARSAT-1 data © Canadian Space Agency 2001. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International (RSI). SPOT data © CNES and Spotimage 2001. LANDSAT data distributed by RSI. Produced and provided by GAF.

worldwide. Images acquired this year included the Baltic Sea, Italy, Indonesia, and Lebanon. Of particular significance were scenes acquired of the horrific September 11, 2001 terrorist attacks on New York City and Washington, D.C.

Hurricane Watch 2001

CSA, CCRS, and NOAA's Atlantic Oceanographic and Meteorological Laboratory collaborated again to support Hurricane Watch 2001. This year, coverage was expanded to include Atlantic Basin Extra-Tropical transition storms in the Mid-Atlantic (above 40°N), as well as the tropical Eastern Pacific Basin. As a result of CSA's more proactive role in 2001, a six-fold increase in submissions and a 10-fold increase in the number of eye hits were realized. Furthermore, CSA launched a new website that provides timely, graphical representations of planned acquisitions to the partner organizations. Once each hurricane dissipated final acquisition status and results including quick-look images provided by CCRS were posted on the website.

In 2001, the program acquired images of the eyes of Hurricanes Chantal, Erin, Felix and Humberto in the Atlantic Basin, and of Dalila, Flossie, Gil and Juliette in the Pacific Basin,

augmenting similar observations made during the three previous hurricane seasons. Once again more images showing well-organized, secondary atmospheric flow phenomena were produced, which may help scientists better understand hurricane dynamics and intensity changes.

ANTARCTICA

A NEW AGE OF EXPLORATION

This cutaway perspective of Antarctica produced by National Geographic Maps was featured as a supplement to the February 2002 issue of National Geographic Magazine. The BEDMAP Consortium, an organization that includes scientists from 12 countries, provided data for the terrain model that is overlaid with RADARSAT-1 satellite imagery of surface details. The RADARSAT-1 satellite revealed new details of the Southern Continent during its two mapping missions of Antarctica. The extraordinary digital mosaic created in 1999, after two years of compiling 4 500 scenes from RADARSAT-1's first mission in 1997, continues to be used to benefit the work of scientists in understanding the role Antarctica plays in global climate change.

ANTARCTIC PENINSULA

RONNE ICE SHELF

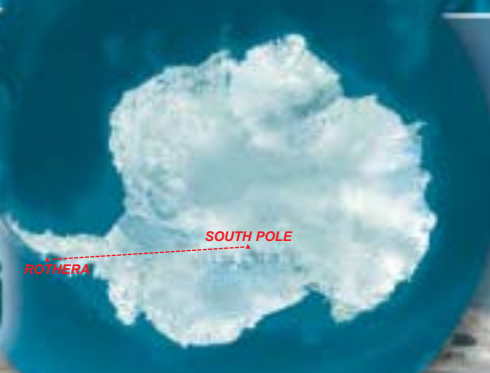
WEST ANTARCTICA

TRANSANTARCTICA

SOUTH POLE

ROSS ICE

© 2002 National Geographic Society. Byrd Glacier image courtesy of NASA/Goddard Space Flight Center - Scientific Visualization Studio and the United States Geological Survey. BEDMAP dataset courtesy of David Vaughan and the BEDMAP Consortium. RADARSAT-1 data © Canadian Space Agency 1997. Received by the Alaska SAR Facility (ASF), Canada Centre for Remote Sensing and McMurdo Station. Processed by ASF and RADARSAT International (RSI). Photographs © Natural Environment Research Council - British Antarctic Survey.





Research Stations
■ Permanent
■ Seasonal
■ Automatic weather stations

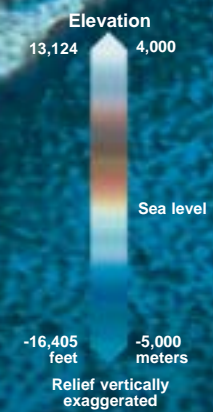
N MAUD LAND

EAST ANTARCTICA

ANTARCTIC MOUNTAINS
SHELF

On April 24, 2001, a leading Canadian polar air travel service, Calgary, Alberta based Kenn Borek Air Ltd., evacuated Dr. Ronald Shemenski from the Amundsen-Scott South Pole station after he suffered a severe attack of pancreatitis. After flying from Canada to Punta Arenas in Chile, the two Canadian Twin Otter planes and their four pilots battled -60 °C temperatures, intense winds and polar darkness to land at the Rothera Air Base on Adelaide Island (where a back-up plane would remain). The pilots then flew for 10 hours to the South Pole station to rescue the U.S. doctor.

Source: The Ottawa Citizen/National Post



RADARSAT-1 continues to be the data source of choice for Canadian Ice Service (CIS) operations. More than 3 800 scenes were received in 2001, increasing the total number of scenes acquired since early 1996 to nearly 21 000.

During the past year, CIS and CSA negotiated a new service contract with RSI to maintain data processing and image data delivery for Canadian government clients until the end of RADARSAT-1's lifetime. This new contract reduces the cost of data pricing from CDPF to these clients by more than half. Although RADARSAT-1 is now operating beyond its original design life, CIS looks forward to continued reliable operations and availability of RADARSAT-1 data until RADARSAT-2 is launched and operational.

ScanSAR data ordered for CIS ice monitoring operations often captures dramatic snapshots of atmospheric conditions imprinted on the ocean surface in those areas where ice is not present. In the last several years there has been a growing interest in using satellite SAR data to extract marine meteorological information. With this in mind, CIS carried out a CSA-supported demonstration project during the winter of 2001 to take advantage of and exploit CIS's operational RADARSAT-1 data stream.

As part of the "Winds from SAR" demonstration, the Canadian Ice Service (CIS) delivered this ScanSAR Wide data product to the Thunder Bay Regional Weather Centre in Ontario, Canada. Wind-induced striations and surface features illustrated by variations in tone/backscatter can be seen in Lakes Superior and Michigan. Because the contrast was enhanced to highlight the backscatter variations in the water bodies, the land areas appear bright and the urban areas appear saturated. RADARSAT-1 data © Canadian Space Agency 2001. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International. Produced and provided by CIS.



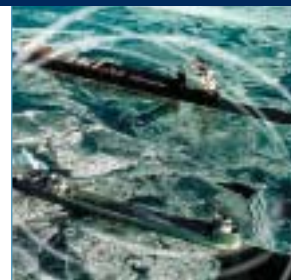
From January to April 2001, more than 600 RADARSAT-1 ScanSAR images and derived wind products were delivered in near real-time to three meteorological centres on the East Coast and in the Great Lakes region of Canada to assess the utility of RADARSAT-1 data for assisting in marine weather forecasting. Feedback from meteorologists on the use of RADARSAT-1 for weather applications was positive, particularly for site-specific weather forecasting in regions such as coastal or marginal ice zones, lakes, and estuaries where observational data are sparse or where other information from sensors such as scatterometers suffer from low resolution and land contamination. CIS plans to repeat this "Winds from SAR" demonstration in winter 2002.

CIS also works in partnership with the U.S. National Ice Center to monitor ice conditions on the Great Lakes throughout the winter season in support of safe, efficient shipping on lake Erie, lake Huron and lake Michigan year-round. Using RADARSAT-1

images as the primary means of observation, the two national ice services coordinate efforts to provide twice weekly charts to the marine community that show the changing distribution and thickness of the ice. Daily bulletins are broadcast on marine radio to update the chart information and to warn of hazardous ice conditions that may be developing. The ice services are in constant contact with the Canadian and US Coast Guards, who operate a combined fleet of two heavy icebreakers and several smaller icebreaking vessels to keep ice jams from forming and to escort vessels through difficult ice.

Data Source of Choice

In this aerial photograph, two lakers—the Southdown Challenger, a US bulk cargo ship, and the Algowest, a Canadian oil tanker—are passing in the Detroit River. Designed to work exclusively on the Great Lakes, lakers navigate in channels cut through the ice by icebreakers. In heavier ice conditions, icebreakers escort the lakers directly. *Aerial photograph © Don Coles.*



Students on Ice organizes unique learning expeditions to the Antarctic and the Arctic, and has led student expeditions to both ends of the Earth since 1999. Students from around the world participate in the expeditions organized by this Ottawa, Ontario based organization, providing inspiring educational opportunities in the Arctic and Antarctica, and in doing so, help students foster a new understanding and respect for the Earth.

Through its Youth Awareness and Education division, CSA contributes to the Students on Ice expedition education programs by incorporating space technology, such as RADARSAT-1, into the expedition curriculum.

CSA's Youth Awareness and Education division has developed a turnkey web-based package of information and learning activities on the science of radar imagery and how it provides vital information about global climate change. The package is available on the CSA KidSpace website at www.space.gc.ca/kidspace.

The success of the Students on Ice expeditions to Antarctica and the Arctic has been tracked via their website www.studentsonice.com, allowing millions to share their experiences and the educational benefits of the expeditions. The Education Programs for the Students on Ice expeditions are multi-faceted. A pre-expedition program helps prepare students for their learning adventures. During the expeditions, the students are immersed in lectures, workshops, hands-on research activities and experiential learning opportunities. A world-class team of scientists, educators and expedition experts work and travel with the students throughout the expedition.

Thousands of students of all ages, from across Canada and around the world, follow the expeditions on the Internet. During the Antarctic and Arctic expeditions, daily live Internet links via satellite allow the students to share digital photos, journals, discoveries, and much more.



Shown at left is the 2001 Students on Ice Arctic Expedition visiting a site high above the Itilleq Fjord in Western Greenland. *Photograph courtesy of Students on Ice.*

Students on Ice

In support of two expeditions by Students on Ice in 2001, CSA's Satellite Operations provided RADARSAT-1 images to help students pinpoint the location of their expedition vessels, as well as learn how to interpret the images to better understand the physical environment of the Arctic and Antarctica.

Arctic Expedition 2001

In August 2001, students flew from Ottawa, Ontario and across the Arctic Circle to land in a remote community on Baffin Island. They then boarded their expedition vessel the *M/V Akademik Ioffe* and spent the next 10 days exploring Canada's High Arctic and making their way to Greenland and the expedition's conclusion. On this expedition, an Extended High image of Pond Inlet was acquired on August 20, 2001, in which their expedition ship was visible. In addition, a Standard 7 image of Ilulissat, Greenland was acquired on August 24, 2001 that showed sites where the expedition visited by zodiac.

Antarctic Expedition 2001

In December 2001, students flew from Toronto, Ontario and across two continents to arrive at Ushuaia in Argentina to board their expedition vessel the *Polar Star*. For the next 11 days, the student expedition navigated the rough waters of the Drake Passage, which separates South America from Antarctica, and explored islands off the Antarctic Peninsula. One RADARSAT-1 scene was used on this expedition: a Standard 3 image acquired on December 9, 2001 of Deception Island off the tip of the Antarctic Peninsula.

Both these expeditions provided a unique opportunity to integrate RADARSAT-1 technology into the Students on Ice curriculum, and demonstrate how students can use advanced space-based technologies to facilitate their understanding of the world in which we live.

This Standard 7 image of Ilulissat, Greenland was acquired in support of the Students on Ice expedition to the High Arctic in August 2001. After visiting Baffin Island, the 75 students crossed the Davis Strait in their expedition vessel the *M/V Akademik Ioffe* to explore sites in Greenland's Disko Bay region, including Qilikitsaq where the Greenland Mummies were found 20 years ago, as well as visiting the Arctic Research Station in Qeqertarsuaq and the Greenland Icecap near Illusuaq. RADARSAT-1 data © Canadian Space Agency 2001. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International. Iceberg photograph © Guillaume Dargaud (www.gdargaud.net). Student expedition and expedition ship photographs courtesy of Students on Ice © Brendon Grunewald (www.70south.com).





Total Solutions for

Subject to annual monsoons, the flat Red River Delta in Vietnam is highly susceptible to overland flooding. Using Earth Observation satellites such as RADARSAT-1 and LANDSAT 7 to image the area before flooding, baseline information on land use, settlement patterns, and infrastructure can be collected in readiness for flood mitigation efforts. *RADARSAT-1 data © Canadian Space Agency 2000. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International (RSI). LANDSAT 7 data distributed by RSI. Produced and provided by RSI.*

As a global provider of information solutions derived from multiple EO satellite systems, RADARSAT International (RSI) is working with its partners to offer an unrivalled portfolio of imagery products and expanded services. Former RSI President Mr. Roland Knight said, "As we've learned in the past, the value of EO data is in the information it provides. More than that, however, we recognize that to penetrate new markets and achieve larger market share we need to fully understand the client's business needs and offer an innovative and complete solution that can be easily integrated into the client's operations. I believe RSI's success in 2001 clearly reflected our ability to adapt to this new business environment."

In February 2002 Mr. Phil Gray, former President and General Manager of MDA subsidiary Access BC Information Services, succeeded Mr. Roland Knight as President of RSI. Mr. Knight left the company confident that RSI, under Mr. Gray's new leadership, will continue to respond to the emerging needs of users and ensure RSI's readiness for RADARSAT-2.

RSI and its global community of RADARSAT-1 distributors, value-added partners, and end users are now found in nearly 60 countries. In 2001, four new distributors in Colombia, Greece, Russia, and Turkey, and one new ground station in Brazil signed agreements with RSI and CSA.

Marine Oil Surveillance and Ice Monitoring

RSI's traditional RADARSAT-1 business areas of marine oil surveillance and ice monitoring also contributed significantly to its success last year. Latin America and Europe together generated almost two million dollars in revenue, which was derived from using RADARSAT-1 in the detection of natural and man-made oil seeps. In March 2002, RSI announced that its client Petrobras of Brazil is nearing full implementation of an extensive environmental program in Latin America for oil spill detection and



or Evolving Business Needs

disaster prevention. The program includes a contract with RSI to supply RADARSAT-1 imagery with emergency programming and near-real time processing services.

Clients both in Canada and in Europe continued to rely on RADARSAT-1 in 2001 to monitor ice conditions in northern shipping lanes. Furthermore, RSI is participating in a pilot project that utilizes RADARSAT-1 imagery to monitor river ice in British Columbia to help reduce the risk of ice-jam related flooding and to support effective reservoir operations during the ice season.

New Information Systems and Networks

In another project, supported by the Canadian International Development Agency (CIDA) and partners in Canada and Vietnam, RSI delivered a web-based RADARSAT Flood Information System (RFIS) to provide near-real time information to Vietnam's Disaster Management Center. 2001 was also the first fully operational year for RSI's ICT Dev Group, which is pioneering the development of web-based information networks and building these decision-support tools in support of agriculture, hydrology and environment-related resource management issues.

In February 2002, the ICT Dev Group announced that it was awarded a contract by CIDA for the first phase of the Andaman Environmental Resource Information Network (AERIN) project in southern Thailand. This stage includes a feasibility study that will examine and assess the potential design and implementation of AERIN, as well as technology transfer and training.



New INSAR and DEM Products

Maintaining RADARSAT-1 in a +/- 2 km orbit has enabled RSI to promote new INSAR applications. As well, new business is being realized for RADARSAT-1 derived DEM products. One such opportunity was RSI's delivery of a complete DEM of Colombia to the US National Imagery and Mapping Agency. Another was a product agreement with SYNOPTICS Holding BV of the Netherlands to develop RADARSAT-1 derived DEMs for various parts of the world. In addition, RSI is supplying RADARSAT-1 derived digital elevation data to Jeppesen of Colorado who, in turn, will provide its customers with highly specialized data subsets that will be utilized in terrain avoidance and warning systems and other advanced avionics systems.



Workshops Bolster Data Us

24

Over the past 18 months, CSA, in cooperation with provincial and territorial agencies, Canadian geomatics companies, and RSI, presented a series of RADARSAT-1 workshops in Canada's major cities. The primary goal of the workshops was to promote the use of RADARSAT-1 data by provincial and territorial organizations and introduce RADARSAT-1 applications relevant to each region.

Newfoundland and Labrador

As a result of the successful workshop in the city of St. John's, CSA, RSI and the Department of Industry, Trade and Rural Development of the Government of the Province of Newfoundland and Labrador reached an agreement that will provide the Province with access to RADARSAT-1 data and data products. Under the new agreement, Newfoundland and Labrador will become a Program Partner and be eligible to obtain RADARSAT-1 data at the same costs as other federal, provincial and program partners.

This agreement will also enable Newfoundland and Labrador to utilize RADARSAT-1 to help meet the growing demand for space-based imaging in numerous applications, including environmental monitoring for offshore oil and gas operations and fishing, as well as vessel and ice surveillance. Results of previous initiatives, such as iceberg detection in the Grand



This coloured summer mosaic of Canada's Nunavut, Yukon and Northwest Territories consists of 107 ScanSAR Narrow images, which were acquired over three years. RADARSAT-1 data © Canadian Space Agency 1998-2000. Received by the Canada Centre for Remote Sensing (CCRS). Processed and distributed by RADARSAT International. Produced and provided by CCRS. Inuit photograph © Nick Newbery (www.artictravel.com).

Banks and pipeline-related applications through industrial and international contracts, have also accounted for new economic benefit.

Yukon, Nunavut and Northwest Territories

Workshops were also held in the Yukon, Nunavut and Northwest Territories. As a result, a new data agreement has been initiated with the Yukon.

The Nunavut workshop was held in Iqaluit, and introduced the capabilities of RADARSAT-1 and its applications to the territory's government representatives. The Nunavut Territory is approximately 1.9 million square kilometres, or about one fifth of the entire area of Canada. Most of the region is within the downlink receiving mask of either Gatineau, Quebec (Eastern Nunavut) or Prince Albert, Saskatchewan (Western Nunavut).

RADARSAT-1 is ideally suited for use in Canada's North as the vast region lacks well-defined topographic maps and experiences long periods of darkness, which severely limits the use of optical sensors.

During the Nunavut workshop, the following areas of interest were explored:

- Geoscience (mineral exploration, hydrocarbon exploration)
- Ice mapping (sea ice mapping, floe edge activity, search and rescue)
- Hydrology (snow mapping)
- Oceans (coastline mapping)
- Fisheries
- Environmental protection and disaster management
- Wildlife habitat mapping
- Parks and Tourism

To date, RADARSAT-1 has been primarily utilized in Nunavut to track ice and ship movements. However, the recent workshop acted as a catalyst to stimulate ideas for the use of RADARSAT-1 in this territory and highlighted the potential for much wider humanitarian, environmental and commercial applications in Canada's northern communities.

The second year of the Earth Observation Application Development Program (EOADP) saw the completion of two Requests for Proposals (RFPs), which resulted in several new contracts. These included some of the RADARSAT-1 projects highlighted below.

Oil and Gas Exploration and Impact Assessments

Hatfield and the Research Institute of Petroleum Exploration and Development (RIPED) of PetroChina are working together to use RADARSAT-1 and other EO data sets for oil and gas exploration and environmental impact assessments in the Kuche region (Tarim Basin) in China. Particularly noteworthy is that this proposal was developed as a direct result of the February 2001 Team Canada mission to China and the associated space seminar hosted by CSA and CCRS.

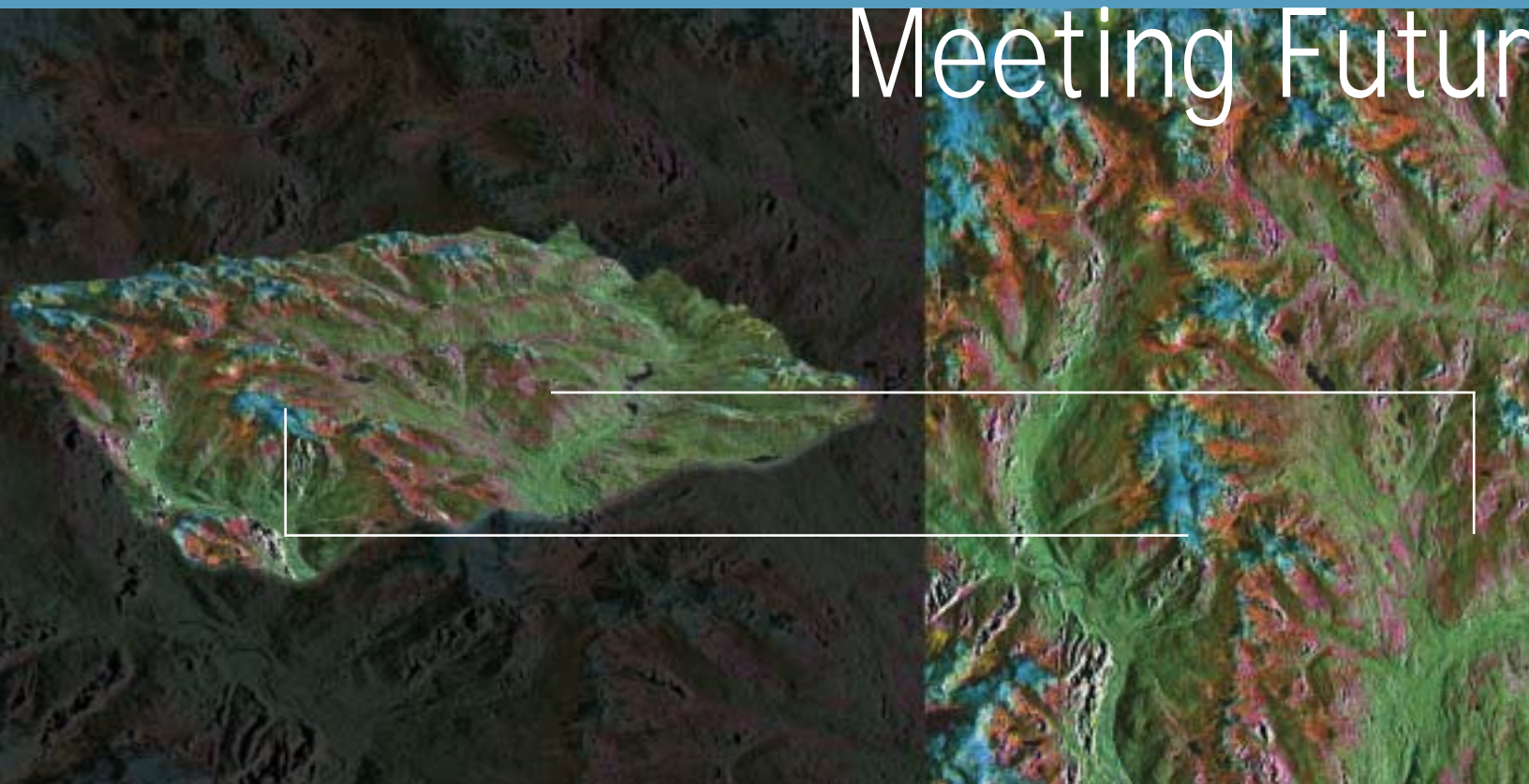
Snow-water Equivalent Extraction

Viasat, in partnership with RSI and INRS-Eau, is developing and evaluating a methodology using RADARSAT-1 for the extraction of snow-water equivalent over mountainous terrain. Furthermore, the snow-related information system has the potential of being incorporated into global initiatives to develop hydrological economical models and to encourage limited sustainable use of resources. (See image below.)

Crop Assessment Reporting Service

Digital Environmental Management is working with RSI and the University of Saskatchewan to develop a web-based crop assessment reporting service using RADARSAT-1 data. Its goal is to help process millions of dollars of crop loss insurance claims, and develop maps of crops damaged by wind

This multi-date Fine 2 image of Mt. Sproatt in southern British Columbia was produced as part of a joint project to investigate the use of RADARSAT-1 data in estimating the spatial distribution of snow-water equivalent. The colour composite has been radiometrically corrected to reduce the topographic effect on the radar signal. Project participants were Viasat Geo-Technologies, INRS-Eau, B.C. Hydro, Hydro-Québec, and RADARSAT International. *RADARSAT-1 data © Canadian Space Agency 2001. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International. Produced and provided by Viasat Geo-Technologies.*



and hail. Insurance representatives in the field will be able to download web-based maps. Called e-CARS (Electronic Crop Assessment Reporting Service), this innovative application marks RADARSAT-1's entry into the handheld computer market.

Pipeline Integrity Monitoring

The global pipeline transmission industry faces constant operational threats from encroachment causing mechanical damage to the pipeline infrastructure. Via+ (Calgary, Alberta), a company spun out from the pipeline industry, and C-CORE (St. John's, Newfoundland), an R&D company with remote sensing expertise, are using EO imagery—including RADARSAT-1 SAR images—to help resolve this major industry problem.

Third-party mechanical damage can be the result of road construction, cable laying, farming, and residential and commercial land development. Using RADARSAT-1 and high-resolution optical data, heavy equipment and their associated signatures,

such as wide-area excavations, can be detected. RADARSAT-1 and optical satellite data complement each other: optical data generally offers a higher resolution, while the high reliability, weather independence and near-real-time capabilities of RADARSAT-1 make it the backbone of an operational encroachment monitoring program. The interpretation of RADARSAT-1 data is also improved through the use of optical data, as well as up-to-date GIS data to remove false targets (speckle, permanent structures) from the SAR data.

At present, C-CORE is developing automated encroachment processing software, and is working with European companies and CCRS to improve target detection techniques. Operational pipeline satellite monitoring is now in a pre-commercialization stage, and Via+ is marketing a concept service to the pipeline industry. CSA is supporting this program, initially through ADRO-2, and currently through the EOADP.

Large Earth Observation Needs



Meeting Future Earth Observation Needs

Image description (from left to right)

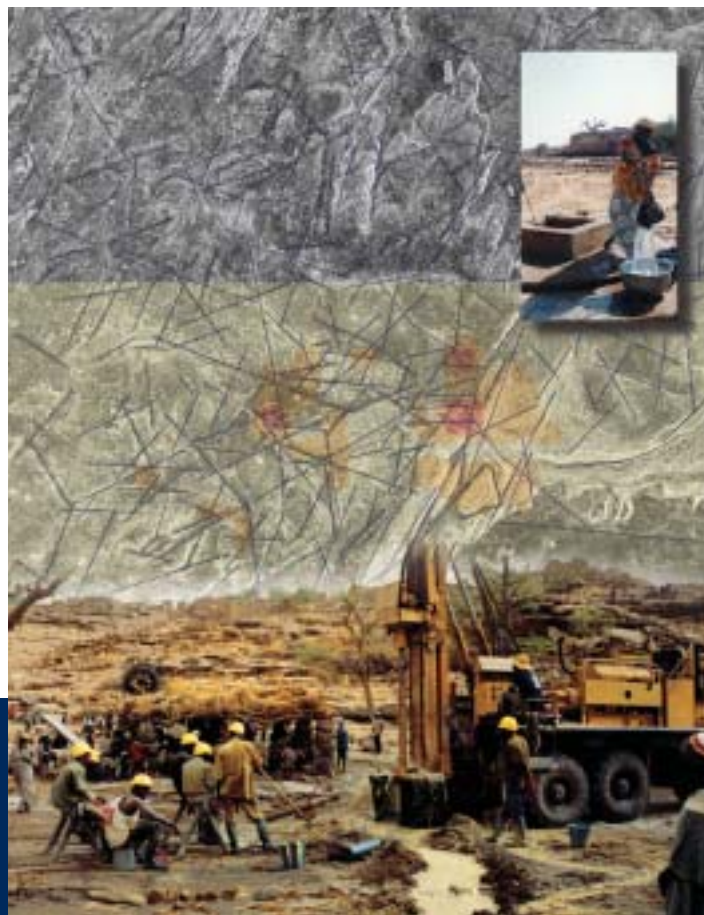
Linear geological structures, called lineaments (blue lines), represent potential water drilling targets in this Fine 4 Far image of Mali. Superimposed on the lower half is a map showing potential aquifers, which was produced by analyzing the lineaments extracted from the RADARSAT-1 data, combined with hydrogeological information. The areas with high potential for aquifers are shown in red and the areas with low potential are shown in yellow. RADARSAT-1 data © Canadian Space Agency 1999. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International. Produced and provided by Tecsult International Limited.

A digital terrain elevation model of an area in southern Alberta was produced using repeat-pass interferometry and Fine 1 images acquired on September 18 and October 12, 2000. The north-south trending corrugated effect visible in the top left results from differences in the surface elevation between strips of fields with crops and those that were fallow. RADARSAT-1 data © Canadian Space Agency 2000. Received by the Canada Centre for Remote Sensing. Processed and distributed by RADARSAT International. Produced and provided by McMaster University.

RADARSAT-1 may assist health agencies control malaria in tropical areas. These three Standard 7 images represent the classification sequence using a segmentation object-oriented routine. The first (1) is a single-date RADARSAT-1 image; the second (2) shows the segmentation result on the multi-temporal data set, and the third (3) is the object-oriented classification results. Wetland areas (classified in blue) can be seen near Mombasa, an island town located in the bottom part of the image (bright area). Based on the proximity of the wetlands to the populated areas, locations that are at potentially high risk for human malaria may be identified. RADARSAT-1 data © Canadian Space Agency 1999, 2001. Received by the Canada Centre for Remote Sensing (CCRS). Processed and distributed by RADARSAT International. Produced and provided by CCRS. Sampling mosquito larvae in Kenya photograph © International Water Management Institute. Giraffes photograph provided by The Africa Guide (www.africaguide.com) / Photographer: Tina Sloma. Mother and child photograph © WHO / Pierre Viot. Mosquito photograph © David Arnot (www.euromalvac.org).

Groundwater Resource Characterization and Management

Tecsult is evaluating the usefulness of RADARSAT-1 and LANDSAT imagery as an input to mapping activities for groundwater resource characterization and management projects. As water resources become increasingly scarce, it is becoming critical to develop new tools to better define resource availability and improve resource management.



Other 2001 RADARSAT-1 EOADP projects

Atlantis Scientific: Extension of spaceborne interferometric SAR permanent scatterer techniques

Geomat International: Development of prototype altimetric databases

MIR Télédétection: Natural gas exploration

Noetix Research: Development and demonstration of remote sensing based products for multi-user access; development of excessive soil moisture index and unseeded operational demonstration

Paterson, Grant & Watson: Cost-effective geologic mapping and mineral deposit targeting algorithms

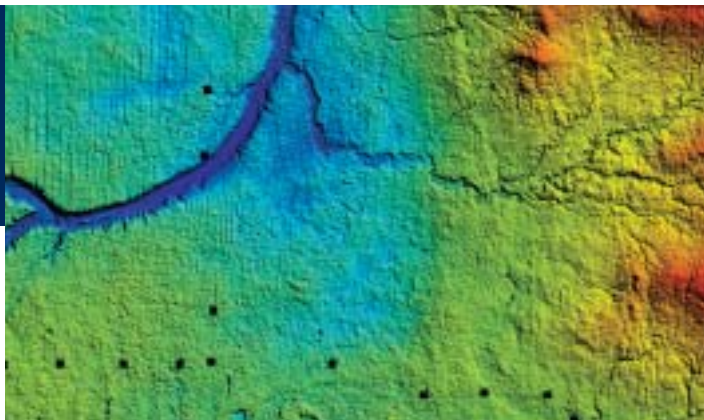
Synetix / Université de Montréal: Updating land use maps

Vantage Point International: Development of a shoreline data acquisition service

The data acquisition campaign for all 36 projects under the second Application Development and Research Opportunity (ADRO-2) program was completed this past year. More than 430 scenes were shipped to ADRO-2 domestic and international investigators, with one third of these scenes drawn from the RADARSAT-1 archives—a key objective of the ADRO-2 program.

The United States has recently completed the first year of its ADRO program, and progress reports on most of the 65 U.S.-sponsored projects have been received. Nearly half are devoted to cryospheric applications; the remaining focus on atmosphere, ecology/biology, oceanography, hydrology, and solid earth disciplines. A better than 86 percent data acquisition success rate has been maintained in the US ADRO projects.

Over the past two years, the RADARSAT-1 Data for Research Use (DRU) program has helped make RADARSAT-1 imagery affordable to the international research community. In total, 22 projects have been received and evaluated, and interest in this CSA and RSI led program continues to grow for both scientific and operational applications.



Disease Monitoring and Risk Assessment

At CCRS, scientists continue to conduct key RADARSAT-1 research projects in the areas of environmental monitoring, natural hazards, coastal mapping, and chromostereo mapping. One applications research project in particular is taking a multi-disciplinary approach in its investigation of the use of RADARSAT-1 in disease monitoring.

29



This CV-580 C/X-SAR multi-polarization composite of the Minas Basin in Nova Scotia was acquired during low tide conditions. The colourful patterns illustrate the differences in the information content of the three images. The yellow line marks the boundary between the dry land and the tidal plane. Oceans and coastal applications will benefit from the enhanced imaging capabilities of RADARSAT-2. CV-580 data © Canada Centre for Remote Sensing (CCRS) 1999. Received, processed, produced, and provided by CCRS.

30

Incorporating state-of-the-art technology, RADARSAT-2 will provide the most advanced commercially available radar imagery in the world, meeting the evolving needs of the global EO market. It will offer all of the imaging modes and products now available on RADARSAT-1, as well as enhanced imaging capabilities such as three-metre resolution, multi-polarization, and dual-side imaging.

Prime contractor MacDonald, Dettwiler and Associates (MDA) reported that development of the RADARSAT-2 satellite has been progressing well. Key project milestones achieved since April 2001 include:

- Completion of the Delta MPDR (Mission Preliminary Design Review)
- Completion of the ground segment PDR (Preliminary Design Review)
- Completion of the advanced CLA (Coupled Load Analysis)
- First beam formed on the engineering model payload column
- Completion of PDRs for all subsystems and Critical Design Reviews (CDRs) for the majority of the subsystems
- Holding of the ESS (Extendible Support Structure) CDR
- Completion of the manufacturing of flight antenna sub-arrays

In addition, MDA announced in January 2002 that the satellite BUS section successfully passed its Critical Design Review (CDR). The CDR marks a critical point in the construction of the satellite whereby the design is approved and manufacturing can be completed. Delivery of the main satellite systems to the David Florida Laboratory in Ottawa, for the integration and testing of the spacecraft, is targeted for early 2003.



Advancing Earth Observation

Operating in C-band, RADARSAT-2 will ensure the continuity of all existing RADARSAT-1 beam modes, while offering powerful new capabilities ranging from major improvements in spatial resolution to full flexibility in the selection of polarization options. *Artist version of RADARSAT-2 courtesy of MDA.*



CSA continues to help the Canadian EO community understand the concepts, develop the tools and explore the potential of RADARSAT-2 data and data products. To this end, CSA sponsored a CV-580 C/X-SAR airborne mission that will collect polarimetric data. This simulated data will be used in preliminary scientific and research projects undertaken by the public and private sector.

RADARSAT-2/3 Tandem Mission: An Innovative Opportunity

In February 2002, CSA announced the extension of the contract with MDA to extend the mission feasibility study for the proposed RADARSAT-2/3 Topographic Mission. The extension of this leading-edge project, developed jointly by CSA and MDA, demonstrates CSA's commitment to innovative research and development. This topographic mission will not only open a wide range of new applications but also strengthen Canada's leadership and expertise in the growing EO market.

Depending on the results of the feasibility study and following the securing of government approval and funding, plans are to launch RADARSAT-3 a few years after the launch of RADARSAT-2, and fly the two satellites in tandem to gather detailed data on the

terrain and elevation characteristics of the Earth's surface. CSA has already funded specific modifications to the RADARSAT-2 spacecraft to support the proposed tandem mission with RADARSAT-3. These include a more robust encryption scheme, an increased onboard storage capability, and modified sensor electronics to permit synchronization of the SAR instrument with the proposed RADARSAT-3 satellite.

This proposed tandem mission represents the most advanced spaceborne land information and mapping mission ever conceived. Data produced by the RADARSAT-2/3 tandem mission is intended to support government and commercial applications that need land information, including natural resource exploration,

The Canadian Space Agency



The mandate of the Canadian Space Agency (CSA) is to promote the peaceful use and development of space, advance the knowledge of space through science, and ensure that space science and technology provide social and economic benefits for Canadians. As a result, CSA promotes an environment where all levels of organizations will pursue excellence collectively, advocate a client-oriented attitude, support employee-oriented practices and open communications, commit to both empowerment and accountability, and pledge to cooperate and work with partners to our mutual benefit.

Canadian Space Agency
6767 route de l'Aéroport
Saint-Hubert, Quebec
J3Y 8Y9
www.space.gc.ca
Tel: +1.450.926.4351
Fax: +1.450.926.4352

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