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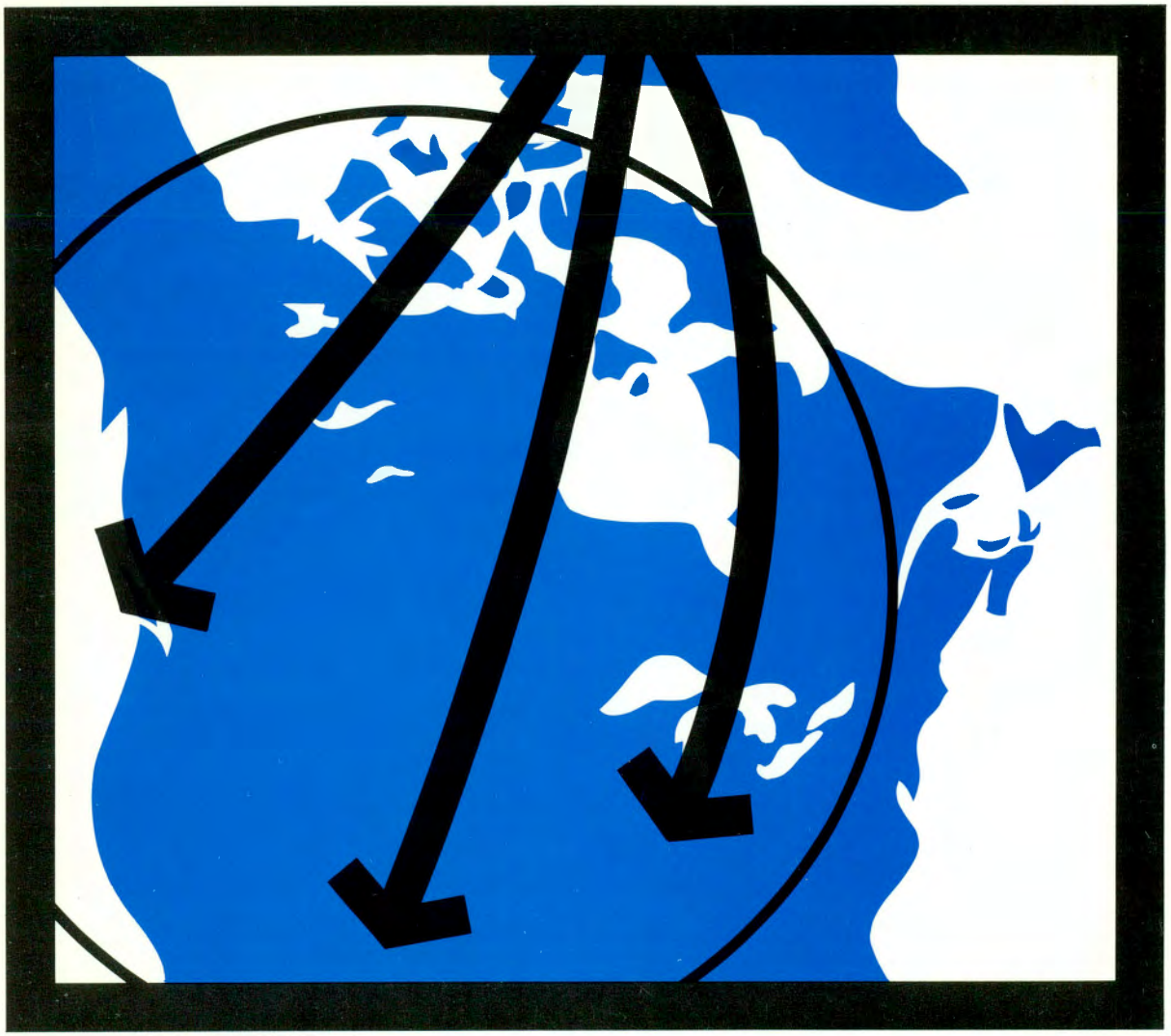
THE CANADIAN ADVISORY COMMITTEE ON REMOTE SENSING



1984 REPORT

Canada

RESORS

Dr. K. Whitham
Chairman
Interagency Committee on Remote Sensing
Department of Energy, Mines and Resources
Ottawa, Ontario
K1A 0E4

Dear Dr. Whitham:

The theme of this year's CACRS meeting was "The Development of a Marketing Plan for Remote Sensing."

An important part of this meeting was the approval of a proposal for planning the involvement of industry in the reception, processing, distribution and marketing of remotely sensed data in Canada.

A panel consisting of:

- Guy Rochon of DIGIM 1983 Inc.
- Brian Bullock of INTERA Technologies Ltd.
- André Fontanel of SPOT-IMAGE Corporation
- Peter Norris of EOSAT Company Ltd.
- Clive Willis of the National Research Council

which was chaired by L.W. Morley provided background information and opinions regarding private sector involvement in remote sensing activities. Workshops which followed the panel recommended in general that the industrial involvement process proceed as quickly as possible. There was some pressure to have the industrial involvement in LANDSAT and SPOT coordinated with private sector investment in RADARSAT, but no clear way of achieving this objective was found.

A second panel chaired by Ed Shaw, RADARSAT Project Director, with panel members:

- Marcel Saint-Pierre, RADARSAT Economist and
  Ed Langham, RADARSAT Mission Requirements
- Stu Borland of Agriculture Canada
- Hubert Allard of AES, Environment Canada
- Boris Borodchak, Canadian Coast Guard

discussed the marketing of RADARSAT and arrived at recommendations for the setting up of a crop information system which would use RADARSAT data and for the RADARSAT Project Office to take initiatives in seeking private-sector investment in the RADARSAT Program.

There was a strong plea to have satellite data available in floppy disk or equivalent form to meet the needs of the personal-computer users' market.

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A highlight of the meeting was the banquet address by the Honourable Robert E.J. Layton, Minister of State for Mines. The Minister urged the provincial representatives to respond to the federal government request for provincial input into the Canadian Space Plan which will be considered by Ministers this autumn.

The meeting was extremely productive and the major recommendations of the meeting are now being implemented.

Yours sincerely,

E.A. Godby
Chairman, Canadian Advisory
Committee on Remote Sensing

September 3, 1985

EXECUTIVE SUMMARY

1984 ANNUAL REPORT

CANADA CENTRE FOR REMOTE SENSING

CANADIAN ADVISORY COMMITTEE ON REMOTE SENSING

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1.0 EXECUTIVE SUMMARY

This is a summary of the discussions that occurred at the annual meeting of the Canadian Advisory Committee on Remote Sensing, which took place at Cornwall, Ontario, from March 25-28, 1985. The attendees at the meeting included the provincial representatives, chairmen of the various CACRS working groups, representatives of the provincial and national remote sensing societies, and invited speakers from Canadian and international industry specializing in marketing remote sensing systems and applications.

General Objective of the Meeting

The general topic of the meeting was "The Development of a Marketing Plan for Remote Sensing." Presentations were made in plenary session by members of a marketing panel chaired by Dr. L.W. Morley. The members were:

- Dr. Clive Willis (National Research Council), speaking about the Canadian Astronaut Program;
- M. Guy Rochon (DIGIM 1983 Inc.), focussing on methods of marketing value-added products;
- Mr. Brian Bullock (INTERA Technologies Ltd.), discussing the challenges facing high-technology marketing;
- Mr. Peter Norris (Earth Observation Satellite Company), outlining the marketing highlights of the commercialization process in the United States;
- M. André Fontanel (SPOT IMAGE Corporation), describing the proposed marketing of SPOT data worldwide.

The plenary group was then broken down into workshop groups to perform the following tasks:

- to approve or comment on the draft plan for the involvement of industry in the production and distribution of remotely sensed satellite data products;
- to approve or comment on the CCRS marketing plan, including the relationship of its activities to those of other agencies whose marketing programs it will complement;
- to approve or comment on priorities for CCRS marketing activities;
- to comment on the extent to which these plans succeed in overcoming the perceived impediments to successful marketing.

The conclusions are summarized below.

Results of the Discussions on Marketing

The workshop group chaired by Ferdinand Bonn agreed in principle with the proposed Task Force to plan the involvement of industry, but felt that the planning process should be speeded up by giving study contracts to private industry during 1985. They felt that the majority of Task Force members should be users and that the Task Force should be chaired by a person working in the area of applications development. This workshop group further felt that the proposed marketing plan in fact covered communications rather than marketing, as it did not seem to be based on a verifiable market survey. They highlighted the need for greater consistency in the quality of data products. They recommended that a CCRS marketing priority should be the production of public-oriented images enhanced by Canadian scientists in various disciplines. To overcome obstacles to successful marketing, they recommended reduced prices for tape products, diskette images and software, guided tours of CCRS, and more newsletter coverage of available publicity aids (films, transparencies, free CCTs for teaching purposes).

The workshop group chaired by Marion Vaisey-Genser felt that there was insufficient industrial participation in the proposed Task Force on industrial involvement, and that its focus was too narrow. They suggested a revised Task Force membership with more industrial users and fewer federal government advisers. In terms of the CCRS marketing plan, they recommended the use of professional marketing expertise in the promotion of remote sensing, along with the development by CCRS of educational kits for various applications. They proposed a greater role for industry in the marketing process, and suggested that marketing activities be targeted to specific market segments, with the highest priority going to professionals, then future professionals, then educated laymen, and last the general public. They placed highest priority on carrying out a market survey, developing a general display, producing educational videos, product and slide catalogues, and technical exhibits, and liaising with and training the media. They also felt that CCRS should place higher priority than at present on producing slide sets, developing new airborne applications, and holding workshops.

The workshop group chaired by Jim Stanley distinguished between the present and future roles of CCRS, in that CCRS will move from provision of data and development of technology to development of pilot and demonstration projects, carrying on more advanced research, and promotion of industrial remote sensing development, both nationally and internationally. They felt that the CCRS marketing objectives should focus first on a public awareness program and then on increased use of remote sensing products and services. The role of CCRS in the resource information domain, they felt, is to provide the effort required to interface remote sensing technology and data with the resource information contained in geographic information systems in order to reach resource management decisions. The role of industry is particularly important in the value-added domain.

The workshop group chaired by Vernon Singhroy agreed in principle with the idea of the industrial involvement Task Force, but felt that a more balanced representation of users on it would be desirable, and expressed concern about the low level of provincial representation. They recommended that the provision of NOAA data be included in the Task Force's considerations and that indeed the provision of microwave data could not be excluded because of industry's need for an assurance of continuity of data. The group expressed support for the marketing plan as a method to promote awareness but felt that it did not adequately address the problem of broadening the market; they looked for a balance between general awareness and market segment development, focussing on the demonstration of remote sensing technology to resource managers who control budgets. They also suggested a stronger link between CCRS marketing activities and those of other federal agencies, and a greater exploitation of the complementary marketing activities of SPOT, EOSAT, and Japan. They recommended a general market survey based on existing information, with identification of the potential users, particularly those not being reached at present. Market expansion objectives should be defined in consultation with the provinces, and activity should focus on specific clients and products. They also recommended that the initial marketing approach to new clients be followed up with applications/engineering support. In terms of priorities in the marketing plan, they felt that all items were valuable, but that it would be desirable to add the production of credible case studies and product introduction packages.

The workshop group chaired by Cal Bricker felt that the scope of the industrial involvement Task Force should be broadened to include the production and distribution of value-added products and other remote sensing opportunities. They recommended that the members on the Task Force include senior industrial representatives from private sector groups such as forestry and petroleum, and that it not be chaired by a CCRS manager. They felt that the marketing plan should have much more explicit goals and objectives, such as:

- to enhance the positive public perception of remote sensing and its value to Canada;
- to contribute to the development of sound and economically viable business opportunities for remote sensing industries;
- to improve user awareness of the usefulness and cost effectiveness of remote sensing information both domestically and internationally;
- and to co-operate with EOSAT and SPOT IMAGE marketing programs.

They felt, in opposition to several other workshop groups, that a market survey should be a low priority item, as would also be marketing initiatives that are costly. Instead, they recommended that CCRS target student populations at both high-school and university levels, and that buttons and stickers be sold. They suggested a route map based on remotely sensed information, to be purchased and used by Air Canada.

RADARSAT Presentation

On the final day of the meeting, presentations were made to the plenary session by members of a RADARSAT panel chaired by Dr. Ed Shaw, Director, RADARSAT Program Office. The panel members were:

- Dr. Stuart Borland, Canada Department of Agriculture, discussing a proposal being supported by CDA for a crop information system;
- Mr. Boris Borodchak, Canadian Coast Guard, emphasizing the need for private sector support and involvement in the RADARSAT program;
- Mr. Hubert Allard, Atmospheric Environment Service, suggesting the need for a comprehensive review of existing and proposed programs;
- Dr. Ed Langham, RADARSAT Office, outlining the present plans and designs for the program and highlighting how the program meets the requirements of users;

- M. Marcel Saint-Pierre, RADARSAT Office, presenting an economist's viewpoint on RADARSAT's domestic and international market and describing strategies for approaching the major segments of the market.

Their presentations focussed on the perceived applications needs for RADARSAT data, and the plans now being made by the RADARSAT Program Office to produce this data. There is an immediate requirement to market the RADARSAT concept in Canada so that its further stages of development will receive funding approval without any delays, aiming for the satellite launch in December 1990. Dr. Shaw summarized by outlining the immediate steps to be taken to gain the support needed by the program from the provinces and territories. Verbal support was given by all present to the RADARSAT program. Follow-up action will be taken by CCRS throughout 1985 to solicit support and concrete proposals from provincial and territorial governments.

IPTASC Recommendations

The Interprovincial/Territorial Advisory Subcommittee, representing all the provincial and territorial governments in Canada, made the following recommendations:

a) that CCRS make a major thrust to develop software for data input and image analysis for appropriate microcomputers;

b) that microfiche or suitable alternatives be made available for the Eastern Canada LANDSAT coverage area (orbits 1-14);

c) that CACRS Working Group hold their 1986 meetings in Edmonton on Monday May 5 in conjunction with the Tenth Canadian Symposium on Remote Sensing;

d) that a full commitment be made for funding of the completion of RADARSAT as currently scheduled (launch date 1990), as this project will bring tangible benefits to all provinces and territories; those regions with persistent cloud cover will in some cases for the first time be able to depend on regular resource management and monitoring data from space.

2.0 THE CANADIAN ADVISORY COMMITTEE ON REMOTE SENSING (CACRS)

Introduction

The Canadian Advisory Committee on Remote Sensing (CACRS) was established in January 1972 to effect the development of a national program of remote sensing. Membership in the committee comprises representatives of provincial and federal organizations, industry and universities. Most members represent a government agency or national working group and thus ensure a broad representation of users, scientists and technologists. Annual meetings are held each calendar year to review programs and make recommendations.

Terms of Reference of CACRS

The Canadian Advisory Committee on Remote Sensing has the following purposes:

1. Advising and assisting the Government of Canada, through the Minister of Energy, Mines and Resources, in meeting the objectives of the national program of remote sensing, by assessing national needs and capabilities and making recommendations regarding existing and proposed programs funded by EMR.

2. Advising and assisting all participants in the national program of remote sensing in the application of remote sensing techniques to the nation's resource management systems by:

   - studying the need for technology transfer to the end-user and industry;
   - promoting the active participation of interested parties in the execution of such transfer, and facilitating the coordination of their efforts;
   - evaluating the results.

3. Promoting the development and diffusion of remote sensing methods and applications by:

   - promoting research and development activity;
   - exchanging scientific and technical information;
   - organizing conferences, seminars, and training courses.

Structure of CACRS

The Canadian Advisory Committee on Remote Sensing is structured as follows:

Chairman:	Director General, CCRS
Executive:	An executive committee was established in 1981 with terms of reference and structure described immediately below.
IPTASC:	The Interprovincial/-Territorial Advisory Subcommittee of CACRS is a body of representatives appointed to CACRS on the recommendation of the provinces and territories.
Working Groups:	CACRS established such working groups as it deems necessary to carry out its work. Some of the groups may operate on an ongoing basis, while others may be ad hoc groups appointed to carry out a specific task and then disbanded upon completion of the task.
Secretariat:	Provided by CCRS.

Terms of Reference of the CACRS Executive

The Canadian Advisory Committee on Remote Sensing has an Executive with the following functions:

1. To analyze and rank, in order of priority, the recommendations of CACRS.

2. To decide on realistic methods of implementing these recommendations.

3. To review and approve the work plans of the working groups and to provide guidance to improve effectiveness.

4. To approve the establishment and terms of reference of limited-life working groups to meet specific needs.

5. To oversee special studies.

6. To prepare plans for and to oversee the reorganization or evolution of CACRS.

7. To plan and coordinate the organization of the annual CACRS meeting.

8. To approve a summary of the results and recommendations of the annual CACRS meeting for transmittal to a higher authority (i.e. IACRS in the case of the federal government).

9. To review the above-listed Terms of Reference at the CACRS annual meeting.

Structure of the CACRS Executive

The representation on the CACRS Executive is as follows:

Chairman:	Director General, CCRS.
Provinces:	Chairman, Vice-Chairman, and Past Chairman, IPTASC (Inter-provincial/Territorial Advisory Subcommittee of CACRS).
Working Groups:	Two representatives elected by the working group chairmen, to be appointed for a two-year term.
Industry:	A representative of Canadian industry may be invited on an as-required basis to address a particular agenda item at an Executive meeting.
Universities:	The Chairman, Education Working Group.

3.0 RECOMMENDATIONS OF CACRS

These recommendations have been extracted from the reports of the provinces, the working groups, and the specialty groups, all of which may be found in full in the minutes of the 1985 CACRS meeting. They have been considered by the CACRS Executive, and the comments of the Executive have in some cases been expanded upon by CCRS.

3.1 Continuity of Data

3.1.1 That CCRS assure the availability of new data as images on a quasi-operational basis - for example, TM and SPOT data. During the next few decades, mapping programs will continue to require photographic images that could be made available in a "quick-look" product, in advance of the final imagery.

- Ontario

CCRS appreciates the needs of users for quick-look data and is currently producing TM data in quick-look format. SPOT data will also be produced in quick-look when available.

3.1.2 The Maritime Remote Sensing Committee is concerned about the lack of sufficient, good satellite images over the Atlantic region and supports the IPTASC recommendation that CCRS aggressively negotiate agreements for necessary Canadian coverage with all existing and proposed sensing platforms.

- Maritime Remote Sensing Committee

CCRS is in full agreement with this recommendation and continues to seek means to assure the greatest degree of continuity of data in all areas of Canada.

3.2 East Coast Coverage

3.2.1 That microfiche or suitable alternatives be made available for the Eastern Canada LANDSAT coverage area (orbits 1-14).

- IPTASC

At present, information is available from Goddard on a printout to cover the Eastern Canada LANDSAT coverage area. CCRS is also investigating the possibility of providing a microfiche product.

3.2.2 As the coverage of microfiche used as an aid to product ordering has been limited to those areas covered by the Canadian ground station at Prince Albert, it is suggested either that this item be removed from the CCRS product listing or that some substitute aid be provided for Maritime users.

- New Brunswick

See response to 3.2.1.

3.2.3 Given that East Coast users of LANDSAT data are faced with using data from both Canadian and U.S. suppliers in a variety of formats, it is recommended that CCRS look at ways of assisting users so that the inconvenience caused by these circumstances is eliminated or minimized.

- New Brunswick

The East Coast users can order bulk and geocoded (DICS) products from LANDSAT MSS data. The geocoded products are in the same format independent of the origin of the data: PASS, SCSS and EDC. The only variation is that for the EDC data, the imagery has already been radiometrically corrected on the FSFC MIPS system and the only option that the user has is "CAL2 LINEAR".

The bulk products ordered from EDC have some differences compared to the CCRS CCTs; however, most of these differences are in the data contents, not the format. At the radiometric level, the dynamic range of the pixels is 0 to 127 D.L. (7 bits) for the EDC data compared with 0 to 255 D.L. (8 bits) for the Canadian data. At the geometric level, the EDC bulk products can be ordered either without geometric correction (raw) or with geometric correction in the Space Oblique Mercator (SOM). Raw pixels are 57 x 81 metres while corrected pixels are 57 x 57 metres.

The CCRS bulk products are always 57 x 81 metres and include some or all of the following corrections: earth rotation, mirror velocity profile, panoramic, earth curvature, line length variation.

Both the EDC and the CCRS CCTs are in "Standard Format" and meet the rules stated in the format. However, there are minor differences at the image record level. For example, the EDC CCTs do not yet include the line or

band numbers as part of each image record (see DMD-TM-82-296 for details).

It is suggested that users who need compatibility between data from multiple sources should use the geocoded products. It would not be practical for CCRS to develop a system to convert the EDC raw MSS CCTs into CCRS bulk products.

Depending on the digital and photographic processing and the type of film, Canadian and U.S. data have always shown a difference in colour balance. The format of the film annotation is also different but both meet the same minimum annotation standards as defined by LGSOWG in the 1970s.

3.3 **RADARSAT**

3.3.1 That a full commitment be made for funding of the completion of RADARSAT as currently scheduled (i.e. launch in 1990). This project will bring tangible benefits to all Provinces and Territories. Those regions with persistent cloud cover will in some cases for the first time be able to depend on receiving regular resource management and monitoring data from space.

- IPTASC

CCRS greatly appreciates this strong statement of support from IPTASC for the RADARSAT program, and will be working closely with the provinces and territories during 1985 to develop the commitments needed to ensure the success of the program.

3.3.2 That the airborne C-Band radar be made operational for the 1985 summer field season under the Canadian microwave (RADARSAT) program.

- Agriculture

All measures possible are being taken to ensure that airborne radar data is obtained during 1985.

3.3.3 The AWG expressed appreciation to CACRS for the support given to advance the microwave program through:

(a) Acquisition of airborne radar data over agricultural test sites (viz Melfort, Outlook, Swift Current and Raymond) for the 1983 and 1984 field seasons.

(b) Establishing a Ground Microwave Laboratory. This laboratory will contribute significantly to the identification of soil and vegetative features that influence radar backscatter from satellite and airborne radar imaging systems. It will assist in delineating the potential limits of various types of radar imagery under the Canadian RADARSAT program for a crop information system.

- Agriculture

CCRS is grateful for this expression of appreciation from the Agriculture Working Group.

3.3.4 That CCRS ensure sufficient funding be available to maintain a viable research effort in conjunction with the Ground Microwave Laboratory.

- Agriculture

CCRS and Canada Agriculture have assembled the funds to make a basic configuration of the Ground Microwave Laboratory operational. It is expected that interested research groups will seek additional funding to cover a portion of future costs.

3.3.5 That the Radar sub-committee be retained under the Agriculture Working Group for a second two-year period (April 1985 to March 1987). This will assist in coordinating the studies of the Ground Microwave Laboratory with those from the airborne systems in relation to agricultural applications relative to the RADARSAT program under CCRS.

- Agriculture

The lifetime of the Radar sub-committee has been extended until May 1987.

3.4 **Cost of Data**

3.4.1 That, for users of small amounts (e.g. small subscene sections) of satellite data, new methods of marketing data be devised, for example, selling satellite digital data on a per-pixel basis. (This pricing structure would not apply to users of large amounts [many full scenes] of such data, or to CCRS airborne data).

- Forestry

This recommendation has been forwarded to the User Assistance and Marketing Unit for consideration. CCRS is taking steps toward the introduction of floppy disks as a data storage medium, which will reduce the price of small-quantity products. See response to 3.11.4.

3.5 **R&D Funding**

3.5.1 Whereas there are at least five major university groups active in remote sensing research in Canada and CCRS supports none directly, the Working Group on Education recommends that CCRS participate in the Research Grants Programme of its department (EMR) in the amount of approximately $100,000.00 annually, which would enable contributions to be made to the financing of five projects at an average of $20,000.00.

- Education

CCRS has never participated in the EMR Research Grants Program but will give consideration to the idea of doing so. CCRS also points out that it indirectly subsidizes the cost of research in several ways, such as the reduced line-mile charge for research projects. CCRS does contribute to PRAI and IRAP grants. These grants are administered by NSERC and, in both, a role is identified for university research.

3.5.2 Whereas the structure of NSERC does not really do justice to remote sensing, in particular to the programme of TM research, the Working Group on Education recommends that CCRS put at the disposal of NSERC, experts whose role would be aimed at tracking down and encouraging remote sensing applications addressed to NSERC, and who would be disposed to sit on its committees. In particular, we ask NSERC that "remote sensing" appear in the new codes for discipline classifications.

- Education

CCRS agrees that a clearer identification for "remote sensing" is required in the NSERC Strategic Grants guidelines, where it does not now appear as a keyword at all, and that a remote sensing specialist should be appointed if possible to the Strategic Grants Committee. The Chairman of the Education Working Group and several CCRS representatives are in touch with NSERC on this matter and negotiations are continuing.

3.5.3 Whereas other federal agencies supporting university research (Agriculture Canada, Environment Canada, Fisheries and Oceans Canada etc.) are often poorly informed about remote sensing, the Working Group on Education proposes that CCRS actively engage these organizations to help them evaluate requests that make use of remote sensing.

- Education

CCRS suggests that the CACRS representatives from the organizations named here are perhaps in the best position to influence this matter. When the detailed report presently being developed by the Education Working Group is finished, CCRS will send copies of it to IACRS members to ensure high-level attention to this area of concern.

3.5.4 That CCRS explore various avenues for funding university projects in ocean science remote sensing. The question of university cooperation was brought up in connection with the BIO image processor, which could be used for interesting "university type" research. An NSERC Remote Sensing Strategic Grant similar to the Oceans Strategic Grant is one possibility that should be investigated.

- Oceanography

See response to 3.5.2.

3.6 **Airborne Program**

3.6.1 That CCRS maintain a strong airborne program for the collection of multispectral (MEIS-II and MSS) Lidar, photo-optical data, and other specialized remote sensing data in order to support studies of atmospheric and geometric correction, as well as studies of basic resource management applications.

- Forestry

CCRS is in full agreement with this recommendation and will continue its best efforts in this direction.

3.6.2 That CCRS continue to support and provide access to MEIS as a vital requirement of the research activities that will be carried out under the coordina-

tion of the CACRS Geoscience Working Group. Access to FLI data and processing software should also be provided in view of that sensor's potential application to geobotany.

- Geoscience

CCRS is in complete agreement with this recommendation and will continue its best efforts in this direction.

3.6.3 The provision of a facility to obtain interpretation quality photographic reproduction of MEIS/MSS flight line data would greatly increase the operational value and attractiveness of the sensors. This capability would make it unnecessary for investigators to include CIR photography in mission requirements.

- Geoscience

CCRS does offer MEIS imagery on its Colour Image Recorder (CIR) as a standard product. Information on format requirements and prices is available from the Digital Methods Division order desk in Ottawa. Alternatively, MDA will produce MEIS imagery using a FIRE-240 recorder.

In addition, more sophisticated routines become available each year at CCRS, in industry, and elsewhere, which can be used to preprocess MEIS imagery for specific applications.

3.6.4 That CCRS maintain the airborne program as a subsidized public program, and that such a program not be put to private industry as long as the sensors are virtually unique in Canada and to CCRS.

- Forestry

CCRS is in general agreement with this recommendation, since it is unlikely that Canadian industry is yet in a position to take the airborne program on completely without government support as at present.

3.6.5 That CCRS announce at least two months in advance its plans to perform data acquisition flights; the location and approximate size of the test site and the name of a CCRS contact person should be given in such announcements, which could be made through the CCRS newsletter or provincial or regional newsletters.

- Nova Scotia

All provincial centres are informed in advance by the Airborne Operations Section of flights planned in their regions. CCRS will use its best endeavours to publicize flights further as recommended, but with changing schedules, dependent upon equipment and weather, this is often difficult to do.

3.7 **Applications Development**

3.7.1 That CCRS continue and expand its support of research efforts in geobotany, focussing on research that develops case histories of geobotanical remote sensing in Canada. The Working Group considers that the following areas have excellent potential as test sites and encourages comprehensive studies in them:

(a) Cameron Lake Test Site (Ontario)

(b) Timmins Test Site (Ontario)

(c) Lynn Lake-Agassis Test Site (Manitoba)

- Geoscience

CCRS will continue its efforts, in cooperation with the Geoscience Working Group, to carry on research in these areas.

3.7.2 That CCRS place greater emphasis on oceanic applications of remote sensing data. One operational use of ocean remote sensing that the Working Group felt might be fruitful is the correlation of sea surface temperatures with fish stock assessment. It is recommended that work on this or other oceanographic subjects should be coordinated with the DFO Fisheries Research Centres and Oceanographic Institutes.

- Oceanography

CCRS awaits the report of the Working Group on Ocean Sciences, expected in August 1985, which should suggest future projects and studies in oceanography in Canada. Once that report is received, the work of the group might be redirected to another project such as this one.

3.7.3 Since the major challenge for new mapping in Canada lies north of 80°, attention should be directed to the

development of remote sensing systems that would assist the production of 1:50 000 maps in this region. There is a particular need for a non-photographic solution to the determination of elevations and contours over arctic icefields.

- Surveys and Mapping

The ability for a satellite to cover the North Pole region is determined by its orbit inclination and the side-looking capability of its sensors. LANDSAT-4 and -5 have an inclination of 98.2° and their most northern images are centred at 80.5° latitude. SPOT will have an inclination of 98.7° and an off-nadir viewing capability of 475 km. This should give SPOT the capability to acquire data up to 86.0° latitude. The RADARSAT SAR sensor will look away from the North Pole (and towards the South Pole); its northern viewing capability will be limited to 76° latitude. However, with the present Canadian station configuration, it is not possible to acquire data in Canada above 79° latitude from PASS and 73° from GSS. For TM X-band reception at PASS it is limited to about 74° latitude.

CCRS is actively seeking the means to develop the high-altitude lidar profilometer, which is essential for a MEIS type solution.

3.7.4 That CCRS take the leading role in coordinating the investigation of diverse sensors for ice remote sensing. This committee believes that there is serious fragmentation in this field, which could be alleviated by, for example,

- a designated, high-level contact person who would maintain a data base on the status of research and applications for ice and allied remote sensing topics;
- frequent workshops on both specific and general topics;
- wider dissemination of the ice community newsletter presently circulated by the RADARSAT Project Office.

- Ice

CCRS is in the process of hiring an ice/oceans specialist who will take the lead in this process. Meanwhile, CCRS notes that C-CORE in Newfoundland maintains a data base on current and recent ice research projects.

3.7.5 That CCRS support the Ice Working Group to sponsor a workshop to develop design criteria for a multisensor experiment or series of experiments for floating ice remote sensing, to include:

- passive microwave technology,
- IR, visual, and low light level methods,
- active radar sensors from all platforms,
- HF radar,
- acoustic techniques, and
- integrated display systems.

- Ice

CCRS would be delighted to support an Ice Working Group initiative in this regard. A potential project is presently being discussed to study ice types in the Northwest Passage.

3.7.6 That CCRS adjust its applications development and technology transfer priorities to match the representation of user groups purchasing its products: for example, 55% of CCRS sales in 1982 were to geological users.

- Ontario

CCRS continously monitors new application opportunities made possible by technological developments. Two such developments being exploited are: the use of electro-optical sensors for geobotany, and the use of microprocessors for known applications, in order to facilitate the transfer of technology to interested parties, such as exploration and mining companies.

3.8 **Technology Enhancement Program**

3.8.1 The Northwest Territories recommends that it be considered when experimental remote sensing studies are planned.

- Northwest Territories

In 1985, the Canadian Hydrographic Service (CHS) will be charting portions

of the southern route through the Northwest Passage, using the LARSEN system, which is the scanning lidar bathymeter developed jointly by CHS and CCRS. This will probably be the largest remote sensing experiment in Canada during 1985.

3.8.2 While it is generally conceded that the Technology Enhancement Program has been helpful to provincial remote sensing users, there is serious danger that these efforts will not pay off to their full extent if the program is terminated abruptly at the same time that users are to be faced with a huge increase in data costs.

- New Brunswick

CCRS is sensitive to the needs of Maritime users and is certainly prepared to study methods of continuing to assist in the development of operational systems in the Maritimes after the formal conclusion of the TEP.

3.8.3 To further the transfer of presently available remote sensing technology as applied to rangelands, particularly to those at the managerial level, that a series of management seminars, technical presentations and/or workshps be held, with the participation of CCRS and the Agriculture Working Group (Rangeland Subcommittee).

- Agriculture

CCRS will be delighted to support any initiatives taken in this area by the Working Group.

3.8.4 That CCRS apprise CIDA of Canadian (private and governmental) expertise in remote sensing and land evaluation as well as on the Canadian state-of-the-art in rangeland applications, as these methods could be effectively applied internationally (e.g., South America, China, Africa).

- Agriculture

CCRS is glad to report increased cooperation and liaison between CIDA and the remote sensing community recently. The range of remote sensing applications, including those mentioned, will be brought to the attention of CIDA.

3.9 **Publications in Support of Technology Transfer**

3.9.1 That the Manual on Remote Sensing of Grasslands by E.K. Watson and A.L. van Ryswyk be published. The first trial edition (25 copies) is being published by Agriculture Canada and will soon be distributed for editorial and technical review. It is visualized for two markets: (1) range managers in U.S. and Canada; and (2) teaching photo-interpretation of range vegetation (universities). After this is reviewed, funding will be needed for the required editorial changes, for colour verification, for inclusion of species from other range climatic zones and for printing of the revised edition.

- Agriculture

CCRS will follow the publication of the first edition of this manual with interest. The Head, Technical Information Section, is in contact with the authors, to give them advice on the publication process.

3.9.2 That the production of an illustrated and comprehensive compendium demonstrating remote sensing applications to rangeland management in Canada (similar to the publication, LANDSAT for Monitoring the Changing Geography of Canada, Geography Working Group) be carried out as a further measure toward effective transfer of this technology to range management agencies. This production could be carried out under the auspices of CCRS or on a contract basis.

- Agriculture

CCRS notes the existence of excellent publications by the Alberta Remote Sensing Center, following the successful conclusion of a demonstration program jointly carried out by ARSC and CCRS.

3.9.3 That CACRS urge CCRS to contract out a study of the Reed report on forest management in Canada to examine how present and future remote sensing technology could be used to help improve forest management, and that CCRS sponsor a contract to have a "manual of

remote sensing techniques in forestry in Canada" prepared for publication.

- Forestry

The new Forestry Working Group might consider ways of undertaking these tasks.

3.10 **Image Analysis Systems and Information Systems**

3.10.1 That CCRS research priorities reflect the following:

a) The critical importance of linking remote sensing output products to geographic information systems. A large effort is required in all aspects of CCRS activity to ensure that sensors and software will permit easy user integration of remote sensing products and geographic data.

b) The importance of MEIS and the need for geometrically corrected data that will interface with geographic data bases.

c) The need for spatial classifiers to handle the data from the next generation of satellite and airborne systems.

d) The importance and need for EXPERT systems to be integrated in the next generation of our image analysis systems.

- IAS Users

CCRS is in full agreement with all these priority statements, and is trying to expedite the work presently being done in these areas.

3.10.2 That CCRS continue to provide access to state-of-the-art image analysis facilities for those tasks that are beyond the practical capabilities of systems in the private sector.

- Geoscience

CCRS will continue to do so.

3.10.3 That CCRS increase its research and development effort in the integration of remotely sensed data with geographic information systems.

- IAS and Artificial Intelligence

See response to 3.10.1.

3.10.4 The AWG supports in principle the proposal under development by CCRS for a small demonstration of the Crop Information System operated in conjunction with provincial remote sensing centres for use by marketing agencies.

- Agriculture

CCRS is glad of this support and appreciates the initiatives taken by the Canada Department of Agriculture in this project.

3.10.5 That CCRS develop in cooperation with the AISAI working group a proposal for an Artificial Intelligence Institute for Planetary Information involving industry, universities, and government. A subset of the working group should visit Japan to assess their technology and organization.

- IAS and Artificial Intelligence

CCRS proposes to forward the minutes of the most recent meeting of the Working Group to IACRS in order to obtain some firm direction for the future of this Working Group. It is possible that the scope of its ideas lies outside the mandate of the remote sensing community.

The CCRS Executive felt that it might be more advantageous to strengthen existing university research programs rather than to start a new Institute at this time, and also noted the present involvement of the Canadian Institute for Advanced Research in this field.

3.10.6 That CCRS host a workshop for the IASAI Working Group on expert systems and logic programming.

- IAS and Artificial Intelligence

Such a workshop was held at CCRS 14-16 May 1985. There were approximately 30 participants from universities, industries and government.

3.11 **Microcomputer Processing**

3.11.1 That CCRS direct the necessary effort to ensure the rapid development of micro-based image analysis software through cooperative development programs with the private sector.

- IAS Users

CCRS is supporting the development of such systems through a PILP contribution to Perceptron and Roy Ball Associates. CCRS has also initiated a project to evaluate microcomputer-based image analysis and develop several new applications on such systems.

3.11.2 That CCRS make a major thrust to develop software for data input and image analysis for appropriate microcomputers.

- IPTASC

- See response to 3.11.1.

3.11.3 That CCRS quickly conduct a study of laser disk technology with the objective of producing a low-cost data media product to be used to input remote sensing data to microcomputers.

- IAS Users

The laser-disk industry is quickly maturing and less expensive media/equipment is becoming available. To further the development of systems, especially those related to large data bases, the government has funded a report entitled "A Management Strategy for Optical Data Disk Technology in the Federal Government of Canada".

There will eventually be real cost and reliability advantages in the optical disk medium itself and the associated peripherals to read the data. It is, however, important to remember that there are at least three elements that determine the cost of a product: the cost of the medium, the cost of the transcription of the data to the medium, and the cost of the data itself; the first of these is the smallest at present.

CCRS is following the development of small optical disks such as the 3 and 5 inch diameter versions, which store up to 500 Mbytes and should be available in 2 to 3 years as viable media for distribution of remote sensing products. In the short term, flexible magnetic disks will become available as a distribution medium. (See response to 3.11.4).

3.11.4 That CCRS adopt a standard format and distribution medium for computer-compatible digital image data to be processed on microcomputers, and that production of the data commence as soon as possible.

- Ontario

CCRS will soon be going through the normal DSS channels to request proposals for industrial participation in the production of satellite image products for microcomputer users. The products will be offered on a commercial basis, initially on floppy disks. Later they could be offered on other microcomputer-compatible media such as optical disks.

CCRS expects this to be a competitive situation with possibly multiple suppliers. The data format for the products will be defined in collaboration with industry.

3.12 **Data Formatting**

3.12.1 That CACRS establish a sub-working group of this group concerned with image data base formats, especially the configuration control of the UNIDSK format.

- IAS and Artificial Intelligence

The Chairman of CACRS has agreed to this recommendation and is establishing such a sub-group under the chairmanship of Gordon Plunkett.

3.12.2 That disk-based data base file structures and utilities (e.g. UNIDSK) be standardized so that software applications can be made more portable among user groups.

- Ontario

CCRS is unable to dictate standards for data file structures; thus, each user and manufacturer is free to develop or choose one to suit the specific requirement. UNIDSK, which was originally developed at CCRS and which is still specified in all CCRS-sponsored development contracts, is not used universally, even in Canada. UNIDSK software may be purchased from MDA, Perceptron and Moniteq.

3.12.3 That all CCTs distributed by, or via, CCRS and its associated groups be formatted to LGSOWG format, or that with CCTs formatted otherwise an enclosed

format specification sheet accompany all distributed CCTs.

- Nova Scotia

See response to 3.2.3. In addition, the following information is provided about airborne data. DAMSS imagery will be in LGSOWG format in the spring of 1986, when the ALICE III digitizer is installed in the Falcon. The CCT format will be similar to that of MEIS II, with 1000 pixels per line even though the FOV and IFOV are unchanged from the present specification of DAMSS.

3.13 **Thematic Mapper**

3.13.1 That methods be developed to report on quality content of TM images by 1/16th of scene.

- Nova Scotia

At present there is no mechanism for reporting on quarter/quadrant scenes, but if a microfiche product becomes available (see 3.2.1), this problem would be solved. CCRS will of course continue to provide help and advice to users ordering data from EROS.

3.13.2 That CCRS make every effort to bring the TMBPS system of MDA into operational as soon as possible, to correct the line shifts presently apparent on the TM data, which result from the lack of scan mirror velocity correction.

- Ontario

CCRS is glad to report that the problem with line shifts has been solved.

3.14 **NOAA Data**

3.14.1 The Water Resources Working Group has, in the past, expressed its concern about the availability of NOAA AVHRR data for applications requiring real or near real-time data and archived data. In order to determine the actual needs of users and to determine if, in fact, there is a need for better distribution and archiving of such data, it is recommended that CCRS conduct a market survey to determine who uses NOAA data, who requires these data, what their data requirements are (real-time, archived), and what type of products are required to meet their needs (facsimile, CCT, floppy diskette, etc.). CCRS is requested to report back to the Working Group with its findings.

- Water Resources

CCRS completely agrees that there is a need to determine what the market for AVHRR data really is. Since the RADARSAT Program office is conducting various surveys and is planning to fly an AVHRR instrument, it is the logical body to carry out such a survey, which it will do as part of its present planning process.

3.14.2 That CCRS arrange for PASS to have the capability to translate to computer compatible tape the full 5-band, 10-bit AVHRR data presently being recorded at PASS. This valuable archive exists but cannot be easily accessed for lack of an index or fully used by oceanographers due to the present truncation of data to 8-bit on CCTs.

- Oceanography

The fundamental system design at PASS limits CCT production to 8 bits. It is not possible to re-design the system for 10 bits. Accordingly, two strategies are possible to reduce the data to 8-bit CCTs:

a) selection by the user of any 8 out of 10 bit grouping;

b) 10 to 8 bit compression via a look-up table specified by the user.

CCRS would appreciate the views of the Oceanography Working Group on the better of these schemes.

3.15 **Organization and Communications**

3.15.1 That the Canadian Advisory Committee on Remote Sensing acknowledge the dedication and efforts of Dr. A.R. Mack in agricultural remote sensing during his successful tenure as chairman of the Agriculture Working Group.

- Agriculture

CCRS is delighted to join CACRS in thanking Dr. Mack for his many productive years as Chairman of the Working Group.

3.15.2 That British Columbia have a remote sensing centre facility which, like those of Alberta and Manitoba and the

centre to be established in Saskatchewan, would disseminate multi-disciplinary technical information as well as provide technical expertise. This should be considered under the CCRS Technology Enhancement program.

- Agriculture

The organization of provincial centres is purely a provincial matter. The CACRS Executive note that there is a remote sensing coordinating committee in British Columbia.

3.15.3 That the Forestry, Wildlife, Wildlands Working Group continue to operate as an integral part of the CACRS organization and continue to include a diverse list of professionals in its membership.

- Forestry

The Chairman of CACRS has agreed to extend the lifetime of the Forestry Working Group.

3.15.4 That CACRS Working Groups hold their 1986 meetings in Edmonton, Monday 5 May 1986 in conjunction with the 10th Canadian Symposium on Remote Sensing.

- IPTASC

CCRS has forwarded this invitation to the Chairman of each CACRS working group.

3.15.5 That commercial organizations concerned with cost-effective applications be more fully represented on the CACRS working groups and at the annual meeting.

- Ontario

This very desirable recommendation carries several difficulties with it in its implementation, but the Executive of CACRS will keep it in mind when planning future annual meetings. The CACRS membership statistics show that at present, 26.3% of all working group members are from private industry.

3.16 **Training and Education**

3.16.1 That more emphasis be placed upon training, particularly in practical techniques.

- Ontario

There are many training courses available at present, both in Canada, particularly from provincial centres, and in the United States. CCRS will seek to advertise these courses more thoroughly through its newsletter.

4.0 1984 ANNUAL REPORT CANADA CENTRE FOR REMOTE SENSING

Historical Highlights

1971

APRIL 1: Canada Centre for Remote Sensing officially established, with Dr. L. W. Morley as Director-General.

MAY: Agreement signed between EMR and NASA.

1972

FEB. 22-24: First CACRS (third "Montebello") meeting at Montebello, Québec.

JULY 23: LANDSAT-1 launched.

1973

FEBRUARY 7-9: First Canadian Symposium on Remote Sensing (Ottawa, Ontario).

FEBRUARY 19-22: Second CACRS Meeting, Montebello, Québec.

APRIL: Manitoba Remote Sensing Centre established in Winnipeg.

SEPTEMBER: Ontario Remote Sensing Centre established in Toronto.

1974

FEBRUARY 18-21: Third CACRS Meeting, Montebello, Québec.

APRIL 28-May 1: Second Canadian Symposium on Remote Sensing (Guelph, Ontario).

JUNE: Alberta Remote Sensing Center established in Edmonton.

1975

JANUARY 23: Launch of LANDSAT-2.

MARCH 31-APRIL 3: Fourth CACRS Meeting, Montebello, Québec.

SEPTEMBER 22-24: Third Canadian Symposium on Remote Sensing (Edmonton, Alberta).

1976

MARCH 29-APRIL 1: Fifth CACRS Meeting, Arnprior, Ontario.

1977

APRIL 4-7: Sixth CACRS Meeting, Arnprior, Ontario.

MAY 16-18: Fourth Canadian Symposium on Remote Sensing (Québec, Québec).

JULY: Opening of the Shoe Cove Satellite Station in Newfoundland and subsequent reception of LANDSAT data.

1978

JANUARY 7: Closedown of LANDSAT-1 after 5½ successful years.

MARCH 5: Launch of LANDSAT-3.

APRIL: Launch of HCMM.

APRIL 10-13: Seventh CACRS Meeting, Arnprior, Ontario.

JUNE 27: Launch of SEASAT.

AUGUST 28-31: Fifth Canadian Symposium on Remote Sensing (Victoria, B.C.).

OCTOBER 10: Failure of SEASAT.

DECEMBER: Signing of the Cooperative Agreement between the European Space Agency and Canada, to take effect January 1, 1979.

1979

APRIL 9-12: Eighth CACRS Meeting, Arnprior, Ontario.

1980

APRIL 8-11: Ninth CACRS Meeting, Arnprior, Ontario.

MAY 21-23: Sixth Canadian Symposium on Remote Sensing (Halifax, N.S.).

1981

APRIL 13-16: Tenth CACRS Meeting, Arnprior, Ontario.

SEPTEMBER 7-10: Seventh Canadian Symposium on Remote Sensing (Winnipeg, Manitoba).

1982

MARCH 29-APRIL 1: Eleventh CACRS meeting, Arnprior, Ontario.

JULY 16: Launch of LANDSAT-4.

1983

MARCH 31: Closure of Shoe Cove Satellite Station.

MAY 3-6: Eighth Canadian Symposium on Remote Sensing (Montréal, Québec).

MAY 9-12: Twelfth CACRS Meeting, Arnprior, Ontario.

JULY 27: Closedown of LANDSAT-3 after 7½ years of operation.

1984

MARCH 1: Launch of LANDSAT-5, carrying the Thematic Mapper sensor.

APRIL 16-19: Thirteenth CACRS meeting, Arnprior, Ontario.

JULY 1: Failure of NOAA-8.

JULY 7: MOUs signed between CCRS and SPOT-IMAGE concerning reception of SPOT data.

AUGUST 13-17: Ninth Canadian Symposium on Remote Sensing (St. John's, Newfoundland).

DECEMBER 12: Launch of NOAA-9.

THE CANADA CENTRE FOR REMOTE SENSING

The Canada Centre for Remote Sensing (CCRS) was established in April 1971 as a branch of the federal department of Energy, Mines and Resources.

CCRS develops and demonstrates systems, methods and instruments to acquire, analyze and disseminate natural resources management data obtained from specially equipped aircraft and satellites. The broad viewpoint of the satellites and their regular coverage of the region with specialized sensors offer new technical and economic possibilities for resource management, while aircraft provide a detailed view where needed, and serve as research and development platforms for the development of new applications.

Demonstrated techniques are transferred to industry and the user community, as a contribution to the development of effective information and management systems for Canada's land and ocean resources and environment.

Applications of remote sensing technology include the management of economically accessible forests, forest-fire protection, mineral exploration, improvement of agricultural land use practices, crop monitoring and reporting systems, as well as ice reconnaissance in support of oil and gas operations in the Arctic.

APPLICATIONS TECHNOLOGY

Technology Enhancement Program

The objective of the Technology Enhancement Program is to work with provincial governments to enhance their remote sensing capabilities for natural resource management purposes. To this end, the Canada Centre for Remote Sensing, with the support of other federal departments (e.g. Environment, Agriculture, Statistics Canada), enters into Memoranda of Understanding with provincial governments whereby projects, using proven remote sensing technologies, will be undertaken jointly by personnel from provincial resource agencies and the Technology Enhancement Program Office.

A Memorandum of Understanding with the Government of Manitoba was signed in November 1982. During its term, November, 1982 to June, 1984, seven joint projects were undertaken. The projects and their status are as follows:

Project	Status
1) Crop Data Monitoring	- report distributed
2) Forest Fuel & Wildfire Mapping	- final review underway
3) Inventory of Moose Habitat	- report distributed
4) Valley River Watershed Current Land Use	- report distributed
5) Vegetation Cover on the East Side of Lake Winnipeg	- report being printed
6) Mapping Rangeland in Agro Manitoba	- report distributed
7) Monitoring Irrigation Activity on the Assiniboine Delta Aquifer	- report distributed

The Manitoba Technology Enhancement Program was officially terminated in June 1984. Because the Manitoba Remote Sensing Centre purchased a DIPIX ARIES II image analysis system in March 1984, and has fully trained its staff, it is now able to provide a strong digital image analysis service to users without the direct assistance of a CCRS specialist. The usual ongoing co-operation in the applications area continues (for example, a major crop area estimation project involving Manitoba Agriculture, Manitoba Crop Insurance Corporation, CCRS and Statistics Canada).

A Memorandum of Understanding was signed with the Council of Maritime Premiers in April 1983, on behalf of Nova Scotia, Prince Edward Island and New Brunswick. The current projects and their status are as follows:

Project	Province	Status
Forestry		
Forest Clearcut Monitoring	New Brunswick	Operational procedures for mapping clearcuts underway
Forest Clearcuts and Road Monitoring	Nova Scotia	Project to be completed by March 1985
Forest Depletion Monitoring	Prince Edward Island	Terminated; low provincial financial priority
Agriculture		
Soil Erosion & Field Crop Monitoring	New Brunswick	Project completed; final report in preparation
Blueberry Growing Area Identification	New Brunswick	Under reconsideration
Monitoring & Mapping Blueberry Cropland	Prince Edward Island	Terminated; low provincial financial priority
Field Crop Monitoring and Soil Erosion Assessment	Prince Edward Island	Terminated; low provincial financial priority
Water Resources		
Snow Cover Mapping	New Brunswick	Project completed; activities continuing between provincial government and contractor
Watershed Monitoring	New Brunswick	Project ongoing; completion by March 1985
Snowcover/Snowmelt Mapping	Prince Edward Island	Not active until March 1985
Wildlands		
Inventory and Monitoring of Peatlands	Nova Scotia	Project completed; report in preparation
Geology		
Geological Mapping	Nova Scotia	Project completed
Geological Mapping	New Brunswick	Project ongoing

Early indications of the success of the TEP in the Maritimes come from the continued interest and work by many of the provincial agencies involved in the program. A direct result of the Maritime TEP is a decision by the New Brunswick Department of Agriculture and Agriculture Canada to co-operate in using LANDSAT data to monitor crop rotation in agricultural New Brunswick, as a follow-on to the TEP project, "Soil Erosion and Field Crop Monitoring in New Brunswick."

The Maritime Resource Management Service is upgrading its image analysis system with the acquisition of new peripherals, while actively marketing remote sensing services and executing related contractual work. (It is expected that the Maritimes TEP will be completed during 1985). The Maritime Remote Sensing Committee is currently considering follow-up activities in the Maritimes for the fiscal year 85/86.

Saskatchewan

A Memorandum of Understanding for Co-operation in Remote Sensing was signed between Saskatchewan and Energy, Mines and Resources Canada on January 9, 1985. The Saskatchewan Research Council will host and co-ordinate the Saskatchewan Technology Enhancement Program, in co-operation with participating Saskatchewan resource management departments and agencies.

The current portfolio of projects is as follows:

Department and Branch	Project
Parks & Renewable Resources Forest Fire Control Branch	Interactive Forest Fire Predictive Analysis Forest Fuel Hazard Types Mapping Burned Areas
Forest Management Branch	Mapping Recent Cutover/Burned-over Areas
Wildlife Branch	Mapping White-Tailed Deer Habitat
Agriculture: Irrigation Branch	Mapping Crops Lost to High-Salinity Soils
Saskatchewan Water Corporation	Flood Forecasting
Saskatchewan Crop Insurance Board	Areal Measurements of Fields Seeded to Insured Crops
Saskatchewan Research Council	Mapping Moose and Caribou Habitat

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Newfoundland

Activities associated with a projected Newfoundland TEP are accelerating. A seminar/workshop on the basics of remote sensing was held in St. John's in November, 1984, and was well attended by provincial personnel. TEP staff have held several consultative meetings with representatives of the Newfoundland Department of Development (DOD), the designated co-ordinating agency.

APPLICATIONS DEVELOPMENT PROGRAM

During 1984 the Applications Technology Division continued to carry out research to meet operational requirements for environmental monitoring and assessment, in co-operation with other federal departments, the provincial agencies concerned, and specialists from the private sector, in the following major activities.

Agriculture

Synthetic Aperture Radar (SAR) applications

A major thrust has been the investigation of the extent to which synthetic aperture radar (SAR) can be used in agricultural applications. During the summers of both 1983 and 1984, multi-frequency multitemporal SAR data along with satellite and aircraft visible and infrared (VIR) data were collected at four test areas within western Canada. Analysis has been directed towards understanding the interaction between microwave energy and vegetation as well as defining the synergistic role of SAR and VIR data. Through the Radar Sub-committee of the Agriculture Working Group of CACRS, interested scientists from across the country are contributing to the analysis.

To further our understanding of the interaction of microwave energy with vegetation,

a ground-based three-frequency microwave scatterometer and accompanying data acquisition system has been purchased. It is hoped that this equipment will be operated by Canadian universities in a program agreed upon by the university concerned, CCRS, Agriculture Canada and the Agriculture Working Group of CACRS.

Work on the first part of a study to evaluate the potential of NOAA Advanced Very High Resolution Radiometer (AVHRR) data for crop condition monitoring has been completed. Procedures have been developed to correct the images radiometrically and geometrically and to account for certain land use effects.

Besides this work with low-resolution satellite data, research is also progressing on the establishment of the relationship between crop yield and visible and near infrared reflectances using LANDSAT MSS and TM imagery.

Thematic Mapper

With a view to applying TM data to the study of agriculture, a 3-year research project was set up in May 1983 by CCRS, the Quebec ministère de l'Agriculture, des Pêcheries et de l'Alimentation (MAPA), and the Centre québécois de coordination de la télédétection (CQCT). The first objective of this project is to demonstrate the potential of TM data in developing land use inventories. The crops under study include corn, cereals, hay, rangeland, potatoes, sugar beets and fallow fields. The second objective is to determine soil moisture.

The launch of LANDSAT-5 in March 1984 enabled us to obtain real-time TM images throughout the entire 1984 growing season. A land-use inventory was carried out by MAPA in seven towns in the St. Lawrence Lowlands. The preliminary results deal with a supervised classification of the August 20, 1984 image, and already appear quite satisfactory. Because the results are as interesting using 4 bands as with all six (visible and near infrared), the selection of TM 1, 3, 4 and 5, found to be suitable in simulations done in 1983, has been maintained in the 1984 real-time images.

To illustrate the results obtained, we have been producing land-use maps at a scale of 1:20 000, capable of being overlaid onto the cadastral maps. In addition, the June 1, 1984 image was retained for study of soil moisture. A colour composite was developed from the three bands judged most useful: TM 1, 5, 7. Contrasts in this image were enhanced to bring out the maximum land-use information. Analysis showed a close relation between soil texture and zones identified by colours.

SIR-B Experiment

As part of the SIR-B project on board the Challenger Shuttle Mission in October, 1984, a particular experiment was undertaken aimed at the evaluation of L-band SAR response to vegetation and soil moisture in Saskatchewan. Aircraft X and L band data were collected over four sites in different azimuth directions, with the lines extended to overlap with the planned SIR-B coverage. Detailed airborne VIR data (scanners and photography) were also collected. To provide good documentation of ground conditions, a joint effort was undertaken with the Saskatchewan Ministry of Education that led to the participation of over 50 high schools and 1000 students in collecting field data and soil samples. Due to mechanical problems during the shuttle flight, smaller-than-planned amounts of data were collected. Nevertheless, a relatively large coverage of Saskatchewan was provided. To date, a limited portion of the total set has been processed and delivered by NASA/JPL. Data analysis will continue during 1985-86.

Forestry

Forest applications research concentrated on the development of Thematic Mapper (TM) enhancements for forestry information content, and on the accuracy assessment of forest harvest depletion mapping using Multispectral Scanner (MSS) data.

A LANDSAT-4 scene providing coverage of the Dryden-Lac Seul region in Western Ontario was investigated for spectroradiometric data structure and information content for forest cover types. This was done in conjunction with a considerable amount of ancillary data and with a preliminary attempt at atmospheric correction and radiometric calibrations. TM data acquisitions were also made for areas in New Brunswick and British Columbia. This work is directed towards the development of TM forestry enhancements for use in the near future, as well as towards the investigation of TM data for new forestry applications. Results of the Dryden study are to be published in early 1985.

In co-operation with the Inventory and Planning Branch of the B.C. Ministry of Forests, MSS data for the William's Lake and Cranbrook areas of B.C. were used to visually interpret and delineate forest harvest depletion boundaries. A robust image enhancement was developed for this purpose and multitemporal band 5 overlays were used. A

number of mapping quality measures were developed and applied to two large depletion samples (78 and 65 depletions). The results of this study were presented to the ministry early in 1985.

Rangeland

Previous reports to CACRS have detailed successes in using LANDSAT enhancements for rangeland assessment. These enhancements are now made at the Prince Albert Satellite Station (PASS) and can be obtained by Alberta users directly from the Alberta Remote Sensing Center. Several workshops and seminars were held in 1984 to introduce this technology to range managers.

Research has continued on the evaluation of Thematic Mapper (TM) data for range management applications. Ground and satellite data were collected in 1984, and analysis will be completed in 1985. This project is a joint effort between CCRS, Alberta Energy and Natural Resources and the Alberta Remote Sensing Center.

Geology

Geology activities have concentrated in three areas over the past year; liaison support to the mining industry, geological data integration, and geobotany.

Mining companies wishing to investigate the potential role of digital LANDSAT data in their exploration activities continued to receive scientific support as well as access to the CCRS Image Analysis System. Several companies have made significant commitments to remote sensing based on this experience. There is growing interest in the investigation of airborne imagery in addition to regional LANDSAT data.

A contract has been let to industry in order to assess operational data integration capabilities and needs in the mining industry in Canada. The results of this work will be used to guide future research activities at the basic and applied research levels within and outside CCRS.

The primary new research thrust established in 1984 was in the area of geobotany. This work began with the preparation of a review paper on operational geobotany techniques developed for LANDSAT data over the past four years at CCRS in co-operation with the mining industry. In addition, a contract was let late in 1984 to obtain a review of geobotany needs in Canada as well as an assessment of potential and current capabilities. Several pilot projects were undertaken co-operatively in order to begin assembling test site data sets, which will be analyzed in co-operation with the CACRS Working Group on Geoscience.

USER ASSISTANCE AND MARKETING

The User Assistance and Marketing Unit is responsible for providing information to users and potential users on the Centre and its activities and facilities. The unit also interacts with Canadian remote sensing companies as part of a continuing commitment to Canadian industry and to ensure the close integration of the technology with user needs.

During 1984, the unit continued to respond to numerous user requests, and stepped up its marketing-related activities, including increased media exposure, more contributions to the CCRS newsletter and other publications, and increased contact with Canadian industry.

A new CCRS technical exhibit was displayed at the Ninth Canadian Symposium on Remote Sensing in St. John's, Newfoundland. The unit represented the centre with a display at five other conferences and symposia. Over 25 international delegations were received and introduced to CCRS capabilities, while tours and visits were arranged for 31 Canadian groups. A slide set was prepared on remote sensing for use by the NRC Canadian Astronauts Program and several public events associated with that program were used to increase the visibility of remote sensing.

The unit also produced a draft marketing plan for review and discussion at the annual CACRS meeting in March 1985.

DIGITAL METHODS DIVISION

Methodology Research

Research continued in 1984 into methods and systems to extract information from remotely sensed data. Software and algorithms developed during these activities were incorporated into the LANDSAT Digital Image Analysis System (LDIAS).

Significant effort was expended in the areas of radiometric and geometric preprocessing of imagery. Algorithms were developed to assess and remove radiometric variations due to sensor view angle and to interpolate data for failed detectors. Robust algorithms were developed to allow for the rapid and accurate registration of multisensor (radar as well as optical) data sets.

Co-operative efforts are ongoing with the British Columbia Ministry of Forestry (BCMF) to develop efficient methods for clearcut mapping. A linkage is being established between the LDIAS and the BCMF computer system, which allows for the transfer of digital map information between the two systems. Work is being carried out to utilize digital forest maps in the identification of changes in multitemporal satellite imagery. BCMF and the Petawawa National Forestry Institute (PNFI) are testing LDIAS software on their systems. In parallel with this work, an expert system is also under development with the University of Ottawa, which will utilize the latest concepts and techniques of artificial intelligence to automate the process of change detection.

Research was undertaken in areas related to scene segmentation, particularly of Thematic Mapper and synthetic aperture radar scenes. Segment classifiers were implemented, and improved classification results were demonstrated through the use of segment rather than individual pixel classifiers.

The development and testing of the LDIAS continued in 1984. Image handling software was improved to increase processing throughput. A human-machine interface was developed and incorporated into existing software to enhance the user friendliness of the system. Additional displays in the form of Gould DeAnzas were procured and integrated into the system.

SATELLITE PROGRAM

LANDSAT Satellite Status

The LANDSAT-4 satellite status remains unchanged. LANDSAT-4 MSS data continues to be recorded over the full Prince Albert Satellite Station (PASS) coverage circle (Path 10-west). LANDSAT-4 MSS data of the east coast (Path 9-east) is available on a "special acquisition basis" only because of logistical considerations at the U.S. LANDSAT Receiving Facility at Goddard.

The LANDSAT-5 spacecraft continues to function nominally with no major problems to date. LANDSAT-5 is supplying complete MSS coverage of Canada as well as near complete coverage with the TM sensor (portions of the far north only have been missed on occasion).

In addition to recording LANDSAT-5 MSS data of Canada's East Cost, the U.S. station at Goddard is also recording TM data of the east coast in exchange for the recording of western U.S. data at PASS. Unlike the MSS data, which are archived at EROS in Sioux Falls, South Dakota, the TM HDDTs are forwarded from Goddard to PASS. East-coast MSS data are available from EROS through CCRS at Canadian product prices.

The planning and layout for a proposed LANDSAT receiving station at Churchill, Manitoba, which was put on hold in mid-1983, was dropped as an option this year. This decision was taken because of the requirement for a SPOT reception location with total North American coverage capability.

NOAA Satellite Status

The NOAA-6 and -7 satellites continued to provide data throughout this year. NOAA-8 failed on July 1, 1984 and recovery attempts to date have been unsuccessful. Efforts to return NOAA-8 to operational status are continuing.

NOAA-9 was launched on December 12, 1984 and is still being checked out prior to being placed in an operational mode.

NOAA data products are available through PASS at the published prices for satellite data.

Satellite sales statistics

Calendar Year 1984

	Value $
Black and White	54,599.80
Colour	114,986.95
Bulk CCTs	92,806.55
DICS CCTs	44,746.10
Facsimile	170,612.05
Microfiche	36,653.99
Special Products	3,069.55
	517,474.99
Plus Handling/Sundry Charges	5,016.83
	522,491.82
Less Returns and Adjustments	8,303.98
	514,187.84

Products and Pricing

New pricing schedules for fiscal year 1985-86 are being prepared. It is expected that prices for SPOT products will be similar to LANDSAT Thematic Mapper (TM) quarter-scene

prices. TM prices will be increased slightly (5% range) and most LANDSAT MSS prices will be increased significantly to approximately 80% of world-level pricing. These statements are consistent with the pricing forecast included in this report last year.

SPOT Status

SPOT Reception

In July of 1984 two Memoranda of Understanding (MOUs) were signed: with SPOT-IMAGE, France, for the rights to receive Canadian data, and with SPOT-IMAGE Corporation (SICORP), a United States company, for the rights to receive data of the continental United States and part of Alaska. Following the signing of the MOUs in July, work has continued on defining formal agreements with each organization.

The agreements will allow Canada to develop a program of reception, recording and archiving of SPOT data for all of Canada, commencing with the planned launch of the first satellite in October 1985. SPOT data received as a result of the SICORP agreement will be sent to SICORP for archiving and distribution of SPOT products to United States users. Canada will be reimbursed for the services supplied to SICORP.

Based on the geographic coverage required, the optimum locations for the stations to receive SPOT data are the existing station in Prince Albert, Saskatchewan, and a new location near Ottawa. The site of the new station was determined on the basis of technical criteria and cost. The technical criteria were: geographic coverage provided by the site (hill tops preferred), minimal electro-magnetic interference, nature and accessibility of terrain, and possibility of limited expansion over the next few years. The cost factors covered land, roads, construction, power and other services. A total of eighteen possible sites were surveyed, and seven technically acceptable sites examined in detail. Of the seven technically acceptable sites within the Ottawa area, a site near Carleton Place was recommended as the first choice by EMR to the Department of Public Works for reasons of cost, security and growth potential. A back-up or second-choice site was also identified as a hill in Gatineau, Québec. During negotiations, the City of Gatineau proposed that they would provide the land, access road, and maintenance as well as clear and ready the site for construction within the planned schedule. Although the site proposed by Gatineau was the second choice of the EMR selection committee, it was technically and geographically fully acceptable, the only problem at the time of selection being the cost of development. Therefore, considering the proposal, schedule and cost of both sites it was decided to accept the City of Gatineau's proposal.

The Gatineau station site, approximately 40 acres in size, is located on the top of a wooded hill, 270 meters high. The city will provide an access road suitable for year-round use, clear the site of trees where necessary, to reduce reflections and noise, and obtain the land from the present owners. The station construction is due to start about 15 March after completion of the road.

CCRS is continuing to upgrade the Ottawa equipment to produce pseudo-corrected SPOT products until the MOSAICS system is completed in 1986.

Satellite Data Processing Support and Products

Facilities in Ottawa have continued to provide data processing support and products to the remote sensing community during 1984.

The Time-Sharing System (TSS) continues to provide facilities to support processing of satellite and airborne data together with quality assurance, image analysis, research and development, database and reporting systems. The TSS provided user access to the LANDSAT-1, -2, -3, -4, -5 Image Inventory Search and Summary (IISS) database for MSS, geocoded MSS and TM data. The inventory contains all LANDSAT data recorded and all existing colour products. A LANDSAT-4 and -5 catalogue was printed in March 1985.

In 1984 the Remote Sensing Online Retrieval System (RESORS) was increased by over 5,000 bibliographical references and now contains some 45,000 citations. There are currently 84 online users accessing RESORS either by dial-up lines or DATAPAC lines.

The TSS TRIAD image display subsystem has continued to be used extensively for quality control of digital products and for research projects. The TSS scanning microdensitometer black and white image production subsystem has been used primarily to image radar data (275 films from April 1984 to January 1985).

The LANDSAT production in Ottawa between April 1984 and January 1985 has consisted of:

- Shoe Cove Archive Recovery System: 19 products

- DICS geocoded MSS imagery: 222 products

- TMTS pseudo bulk corrected TM imagery:
  111 scenes (June 1984-January 1985)

Two activities are taking place relative to the MSS archive. All the useful MSS data acquired from LANDSAT-1 and -2 between 1972 and 1975 and recorded on the FR1928 high density tape recorders are being reformatted onto the LANDSAT-4 and -5 compatible HD96 recorders. The first few months of the archive will be completed by April 1985. This transcription of the first two and a half years of data will prevent continued deterioration and loss of the oldest MSS data. Also, a long-term archive policy draft developed in 1984 is being tested on the Shoe Cove archive in order to determine the level of data reduction that can be achieved by applying the policy criteria.

The Colour Image Recorder (CIR) generated 558 film products between April 1984 and January 1985. These products were colour-on-demand products, user customized tape-to-film and DICS film products. In 1984 the CIR was found to require a higher level of maintenance and it will be replaced in 1986 by a new imaging system based on the MDA FIRE recorder.

Satellite Data Processing System Developments

The DICS and CIR sytems have been upgraded to process LANDSAT-5 data. The Thematic Mapper (TM) Transcription System (TMTS) has been enhanced to process LANDSAT-5 TM data and to perform pseudo-bulk correction (earth rotation, line-length correction and radiometric calibration). TMTS throughput has increased from two scenes per week to five scenes per week. In the last months of 1984 the TMTS production capacity exceeded user demand.

Research has been completed in order to quantify the differences in absolute calibration for all five LANDSAT MSS sensors and the two TM sensors. MSS film products are also available on a production basis for softwood, mixedwood, rangeland and customer-defined enhancements.

Work is progressing on schedule for the delivery of the Multi-Observation Satellite Image Correction System (MOSAICS) to the Prince Albert Satellite Station in June 1986. MOSAICS will produce raw, bulk-corrected, system-corrected geocoded and precision-corrected geocoded CCTs and film products from LANDSAT-1, -2, -3, -4, -5 MSS data, LANDSAT-4 and -5 TM data, and SPOT-1 and -2 multispectral and panchromatic data. During 1984 the detailed design was completed, the hardware for the full system was configured and the ability to process MSS and TM data was demonstrated. As a subsystem to MOSAICS the TM Bulk Processing System (TMBPS) was completed and accepted during 1984.

The requirements, specifications and hardware procurement of a new high-resolution 240 mm colour film recorder will be completed in March 1985. As a replacement to the present CIR this new facility will provide high quality CCT to film products for LANDSAT, SPOT, airborne and user imagery beginning in April 1986. The system is based on a FIRE 240 colour film recorder and a VAX computer.

SPOT-related research and development has continued in 1984. It has been demonstrated that digital elevation information can be extracted from satellite stereo images on a production basis using MSS, TM and RBV data for test purposes. Procedures have been developed for the orthographic utilization of off-nadir SPOT imagery. Additionally, the requirements, specification and high-level design will be completed by March 1985 for two SPOT quicklook systems to be developed and installed at the Prince Albert Satellite Station and at the new Gatineau Satellite Station following the launch of SPOT late in 1985. These systems will produce 70 mm quicklook film and catalogue information for both High Resolution Visible (HRV) sensors on SPOT for all scenes acquired over Canada and the United States.

AIRBORNE PROGRAM

Microwave Sensors

The C-band converter was damaged in shipment to Norway for the MIZEX deployment in the spring of 1984. As a result no C-band imagery was collected this year; however, the X- and L-band systems worked well and a large amount of data was collected through to the late fall. As in past years, most of the imagery collected has been in direct support of the RADARSAT program, the observation of the Melfort agricultural test site being the single largest task. Perhaps the most widely publicized project was the SIR-B project. In the course of the eight-day SIR-B mission, the SAR-580 collected data for the Melfort test area in Saskatchewan, for an oceanographic experiment in Long Island Sound and for icebergs off the Labrador coast.

Analysis has continued on the various sea ice data sets that have been acquired in the past few years. Increasing emphasis is now being given to the detection of icebergs and to understanding the backscatter cross-sections of the ocean. A new software package has been

developed for the processing of scatterometer data collected in February 1984 by the SAR-580 during the ESA Wind Scatterometer campaign. The same software has also been used for the reduction of data collected at Melfort.

The X-, L-, C-band SAR was removed from the CV-580 in January, 1985 in preparation for the installation of the new fully digital C-band SAR, C-IRIS. Although delivery of C-IRIS is considerably behind schedule, every effort is being made to ensure that good imagery can be collected throughout the 1985 growing season.

Like- and cross-polarized data from C-IRIS will be recorded in signal form on a High Density Digital Tape (HDDT), which may be processed to image format on the C-Sharp system. A single channel of imagery will be printed with annotation on a dry silver printer in real time on board the aircraft. By the spring of 1986 this will be supplemented with a real-time video display. The same system, which is a derivative of the ALICE displays used in the Falcon, will also format the SAR image onto an HDDT. This HDDT will be used to produce additional quicklook products, and the digital image, at full resolution, may be transcribed directly to CCT for further processing and display.

A small lidar altimeter has been installed in the CV-580 as part of the scatterometer system. The lidar, which has a maximum range of 500 m, will be used mainly to profile waves during ocean backscatter measurements.

CCRS, in co-operation with the Atmospheric Environment Service (DOE) and the Source Development Fund (DSS), has received approval to build a fully digital X-band SAR (X-IRIS), a research radar whose performance is similar to that of C-IRIS. X-IRIS will be offered as an operational sensor on the CV-580 together with C-IRIS, in the spring of 1987. It will then be possible to collect both like- and cross-polarized imagery simultaneously at X- and C-bands. Initially, these data sets will be useful in relating the C-band imagery of RADARSAT and ERS-1 to the more familiar airborne X-band imagery. This process is also expected to be useful in the development of new applications for airborne SARs.

Visible and IR Sensors

1984 is the second year in which MEIS was considered to be an operational sensor and it was once again offered together with the DAMSS as the standard package in the Falcon aircraft. A workshop was held in April 1984 on the use of the MEIS II sensor. Many users were introduced to the details of mission planning, data reduction, corrections and analysis that are required for a successful airborne project. It is believed that, as a result, MEIS imagery is now being used more effectively.

A substantial effort is being made to develop improved radiometric calibrations and correction algorithms for MEIS imagery. The effect of this will be most apparent in water quality and narrow spectral band geobotanical data sets. A novel operating mode has been devised from which imagery with up to 11 bits dynamic range can be constructed. In an internal project, CCRS has developed and demonstrated the algorithms for the correction of the MEIS and DAMSS imagery using the inertial data recorded on MAID.

The ALICE II real-time display was delivered and test-flown on the DC-3 in the fall of 1984. In the spring of 1985 it will be used operationally in the Falcon to ensure that imagery is acquired over the target areas and that the data is recorded properly. At the same time, the old electronics of the DAMSS will be replaced with a new, more robust digitizer, ALICE III. This change should be transparent to the user with the exception that DAMSS CCTs will have the same format as those from MEIS II.

The first trials of LARSEN, the scanning lidar bathymeter, took place on Lake Huron in the late fall using the DC-3. The lidar performed well and the data reduction software is now being exercised. The lidar and its data acquisition system are being prepared for a major survey of the Northwest Passage in August 1985.

The Fluorescence Line Imager (FLI) was flown three times this year. On one of these flights Moniteq leased the DC-3 to collect hydrographic data in Florida and on another, the Department of Fisheries and Oceans used the Falcon to measure the chlorophyll concentration in the Gulf Stream off the Virginia coast.

Aircraft Systems

Activities in this area have directly supported the maintenance and installation of the sensors and systems reported above. The reliability of the high-density tape drives has been improved markedly by the systematic re-engineering of certain sub-systems. In anticipation of the routine geometric correction of MEIS imagery, a precision barometric altimeter has been fitted in the Falcon and interfaced to MAID. In addition, MAID has been modified to accept the data from the

LTN-90 inertial reference unit and to record various other parameters from C-IRIS. Because the DC-3 does not carry a MAID system and navigation data was requested in the FLI mission, old ADAS parts were used to assemble Mini-MAID, which writes the required information on a dedicated track of the HDDT.

In 1985 a LORAN-C receiver will be installed in the CV-580 and interfaced to MAID. LORAN-C will be useful during long deployments over the ocean where INS drift makes it exceedingly difficult to rendez-vous with precisely positioned targets. Similarly a Global Positioning System (GPS/NAVSTAR) receiver will be installed in the Falcon. Both systems will be used principally for flight management (to indicate current position) in the first year, although subsequently the data may be incorporated into guidance displays and the geometric correction algorithm.

Airborne Data Processing Support and Products

The present Airborne System continued to be fully operational in 1984. The high demand by the airborne user community caused the production of CCTs from airborne MEIS, MSS and FLI data to increase considerably in 1984-85 (1075 CCTs between April 1984 and January 1985).

The digital Synthetic Aperture Radar Processing System (C-SHARP) has continued to be fully operational in 1984. 232 SAR-580 products were produced between April 1984 and January 1985.

Airborne Data Processing System Development

In 1984 C-SHARP was upgraded to process the SAR signal data from the Shuttle Imaging Radar (SIR-B) and from the new IRIS SAR to be installed in the CCRS Convair 580 in 1985. Additional development work was conducted to provide quality control display capability on C-SHARP and to offer software tools for impulse response analysis and data calibration.

Work is progressing for the development of a VAX-based airborne data processing system (AIR-2) to be phased into operation in 1986. AIR-2 will have the capability to transcribe MEIS, MSS, FLI and the airborne scatterometer data from HDDTs to CCTs and to correct the imagery geometrically (the FLI capability is being developed under a separate contract by DFO). In particular, AIR-2 will generate geocoded airborne products using the aircraft navigation data for image correction. After the new system is phased into production, the present airborne data processing system, which has been in operation since 1974, will be terminated.

Airborne Operations

The following table summarizes the utilization of CCRS aircraft during the Fiscal Year 1984-85 in each of the four categories under which tasks were flown, as well as the applications discipline for which the tasks were flown, and the province in which they were flown.

The totals are fairly consistent with the 1983-84 season. The slight decrease was due mainly to weather-related restrictions in the Falcon operations.

International projects included

- Norway (MIZEX) CV 580
- Germany (DFVLR) CV 580
- U.S.A. (ERIM) CV 580
  (NASA) Falcon, and
  (Moniteq) DC-3

Airborne operations in the January-March 1985 timeframe will be substantially reduced, mainly as a result of modifications to the CV-580 for fitting the new C-IRIS SAR and to the DC-3 in preparation for the Canadian Hydrographic Service Arctic survey in the summer of 1985.

CCRS AIRCRAFT UTILIZATION
FISCAL YEAR 1984-85

CATEGORY	NUMBER OF TASKS FLOWN	AIRCRAFT HOURS FLOWN
Internal	31	485
External	24	105
Lease	1	24
Co-op	2	41
	58	655
DISCIPLINE		
Agriculture	9	147
Atmospheric Environment	1	7
Cartography	1	7
Forestry, Wildlife, Wildlands		
Geography	1	5
Geology	8	51
Limnology	3	42
Oceanography	9	211
Transport	1	11
Sensor Tests	15	114
Aircraft Tests	1	2
Crew Training	1	29
	58	655

PROVINCE		
British Columbia	1	4
Alberta	0	0
Saskatchewan	4	135
Manitoba	3	23
Ontario	22	127
Québec	9	34
New Brunswick	1	2
Prince Edward Island	0	0
Nova Scotia	3	37
Newfoundland	1	21
North West Territories	2	30
Yukon	1	20
Other	7	178
Various	4	44
	58	655

RADARSAT PROGRAM

Objectives of RADARSAT

The strategic objective of the RADARSAT program is to provide the resource sector with space remote sensing data for Canadian resource management and energy development needs through development of a radar satellite system.

Canadian needs are for ice, iceberg, ship and ocean information over the Arctic and coastal economic zones, and for crop, forest, hydrological and geological mapping over the provinces and territories. The satellite will also provide global wheat crop assessments, global marine winds, and the first radar stereo-geological map of the world.

An in-orbit servicing option is now being proposed to upgrade the RADARSAT satellite, extending its life to 8-10 years in orbit. The in-orbit repair, refueling and retrieval of satellites is a key element of NASA's Space Station concept. Canadian development of a serviceable polar-orbiting remote sensing satellite can be offered as a component of the Space Station Program.

Developments to the Present Time

The technical advantage currently enjoyed by Canada derives from preceding programs of international collaboration, notably:

1977-80 SURSAT (complete)
- a Canadian radar program based on Canadian aircraft and US satellite data
- developed Canadian digital radar ground processing capability
- established feasibility of major applications

1981-88 ERS-1 (on-going)
- a European Space Agency (ESA) radar satellite program in which Canada is a full participant
- Canadian development of advanced ground processor
- Canadian development of image interpretation technology
- Canadian design and construction of space radar subsystems
- pilot project for RADARSAT applications

1980-84 RADARSAT Phase A (complete)
- joint program with US & UK partners
- definition of mission requirements and concept including in-orbit servicing)
- arrangements for space segment cost sharing
- Canadian design of advanced multi-beam space radar
- Canadian design of high speed processor for radar data
- Canadian economic studies

Future Directions

1984-86 RADARSAT Phase B (on-going)
- joint program with US & UK partners
- detailed design studies
- development of international MOUs for Phase C/D
- detailed cost/benefit studies
- national and international market planning
- development of data utilization technology

1986-90 RADARSAT Phase C/D
- joint program with US & UK partners
- construction and testing of engineering components
- construction and integration testing of engineering and flight model of spacecraft
- preparation of user community for RADARSAT data
- development of MOUs with other countries and their

agencies for reception, processing and distribution of global data
- in-orbit refurbishing of satellite (option)
- launch

At the present time Phase B and the associated ERS-1 activities are fully funded. By the end of 1985, the Phase B definition studies will produce a firm technical cost proposal, draft MOUs with our space partners for cost and data sharing, agreements with the government service agencies on how they will exploit the data, cost recovery proposals, and a marketing plan for achieving the export sales of the new technology and services developed by the project. Cabinet approval will be sought through the integrated Space Program to be submitted at the end of 1985. A Canadian decision in early 1986 will conform with the budgetary cycles of our partner countries and maintain the technical continuity and international commitments necessary for the success of the program.

Service to Canada and International Market Opportunities

The satellite will provide:

i) to the Department of the Environment

- daily ice and iceberg radar images of the Arctic and East Coast
- marine wind data that will improve sea state forecasts
- maps of oil spills and their movement

ii) to the Canada Department of Agriculture, the Wheat Board, and Statistics Canada

- optical and radar images of global crops

iii) to the Ministry of Transport and the Department of Fisheries and Oceans

- information on the location of shipping and fishing operations

iv) to provincial governments

- forestry and rangeland management information
- agricultural and regional crop information

v) to mineral exploration industries

- stereo radar images showing structural geomorphology

The project has already achieved a high degree of international recognition. In 1984 Canada was solicited to make presentations on RADARSAT in France, Italy, Switzerland, Germany, the Netherlands and Brazil, to the United Nations and to the (International) committee for Coordination of Earth Observation Satellites, which reports to the Economic Summit Conference. The Economic and Social Commission for Asia and the Pacific (ESCAP) has invited Canada to present its remote sensing space program at its Singapore meeting in April, 1985.

Thanks to its global data gathering capability, RADARSAT will be able to provide data to any nation and could be used to aid agriculture, forestry, hydrology or mineral development in less developed countries, either through direct data sales or through aid programs.

RADARSAT Partnerships

Canada will lead this international remote sensing space program in partnership with the United States and the United Kingdom. Canada will manage the program, build the radar, integrate the spacecraft platform and sensors, and control the satellite after launch. The United Kingdom will provide the space platform and the radar transmitter tube. The United States will provide a launch, an ocean wind instrument, and possibly an optical instrument. Agreements were signed between EMR/NASA and Canada/United Kingdom in September 1982, and draft MOUs for the construction phase will be developed in 1985.

Each country will build its own ground system and will receive data from all sensors. In addition, arrangements will be made with other countries for them to pay to receive data directly from the satellite.

Canada's Competitive Position

The RADARSAT program will maintain the strong competitive position earned by Canadian firms in remote sensing over the last decade. Since the remote sensing program began in 1971, the industry has become an international leader in satellite station, image analysis, and airborne sensor technology. Canada's resource management community, notably in the provincial governments, has developed a significant infrastructure and has the expertise in using remote sensing technology required to guide its practical development to meet its needs. This infrastructure allows all regions to contribute to and participate in the RADARSAT program. Canada's competitive position then

has been based on high technology strength tested and perfected through a knowledgeable user community.

Remote sensing satellites are in the same state of development as communication satellites were a decade ago and could be expected to follow a similar successful evolution. By entering this market early enough we can maintain our established lead in radar technology and build on our unique knowledge of information services. In this way RADARSAT will not only meet Canadian needs but will also allow Canadian industry to maintain and expand its internationally competitive position in remote sensing.

Furthermore, if the option of making the satellite refurbishable in space is adopted, Canadian industry will gain an early entry into the new space repair technology of polar platforms, which will improve the economics of earth observation systems.

5.0 HIGHLIGHTS OF THE REPORTS OF THE WORKING GROUPS

5.1 HIGHLIGHTS OF THE REPORT OF THE AGRICULTURE WORKING GROUP

Successful data acquisition of airborne SAR and ancillary data continued during 1984 at the Melfort, Outlook, Swift Current and Raymond agricultural test sites. Research projects using these data were initiated at co-operating universities. A ground-based microwave laboratory was purchased by CCRS.

The usefulness of airborne MEIS-II data (1 to 3 meter pixels) for detailed soil surveys and estimation of soil erosion was assessed.

The newly formed Rangeland sub-committee summarized the state of knowledge about remote sensing of rangelands in Canada.

Research on methods for implementing remote sensing data into crop information systems has proceeded over both domestic and foreign sites. A multi-agency co-operative effort covered the province of Manitoba.

5.2 HIGHLIGHTS OF THE REPORT OF THE CARTOGRAPHY WORKING GROUP

Achievements during 1984

The first photogrammetric photography from space was obtained over Canada with the Metric Camera of Spacelab-1. A 1:250 000 contoured map compiled from the photography met NATO B-1 standards for accuracy at this scale and 100 m contour interval.

Projects planned for 1985

Photography from the Large Format Camera will become available and this will lead to establishment of mapping capabilities of this sensor. Committees have been set up to study and report on:

1. Geometric and resolution properties required of sensors to be used for cartographic mapping.

2. Comparative capabilities of existing sensors with respect to cartographic roles.

3. Control identification and extension using space imagery.

Status

Satellite imagery is providing useful revision information for about one third of Canada at present. Improved resolution in future sensors should increase this area of application to more than half the country and make the techniques applicable in urban areas. The use of space imagery for the production of maps can now be studied with material available from the Metric Camera and the Large Format Camera. Future work will define the capabilities of SPOT. The status of Canadian mapping is such that these studies will have more relevance to foreign countries than to Canada. Remote sensing techniques relevant to Canadian mapping problems would be those that lead to the determination of elevations and contours over the ice fields of the Arctic islands between 74°N and 83°N.

5.3 HIGHLIGHTS OF THE REPORT OF THE FORESTRY WORKING GROUP

Achievements during 1984

The FWW-WG is pleased to note that its recommendation (3.3.2 - 1983 Report) concerning the use of personal computers and investigations of new digital data formats on diskettes or floppy disks was well received by CCRS, and we hope to see significant advances in the near future.

Ron Hall reports marketing problems identified by the users during a survey to ascertain why remote sensing is not in greater use:

- Targeted or potential users are not aware or familiar with applications or products.
- There is inadequate communication between researchers and users and too few cooperative projects.
- Potential users are satisfied with traditional methods.
- There are not enough successes that are proven or conclusive.
- Low resolution of satellite data is still a problem for operational inventories.
- There is a continuing problem of timely availability of remote sensing imagery.
- Specialized analysis equipment is needed, expensive and not always available.

New initiatives during 1984

Notwithstanding the problems in marketing remote sensing, new initiatives are being taken by the forestry community in different parts of Canada, including new applications of colour-infrared, large-scale aerial photographs for assessment, of bark-beetle green attack trees by interpretation and film digitizing, evaluation of MEIS-II data for insect damage assessment through to unique advances in forestry applications of geo-referenced information systems.

Mr. Jean Beaubien, Laurentian Forest Research Centre, reports that:

The thrust of our research has been to develop jointly with the Centre québécois de coordination de la télédétection (CQCT) a workstation for interactive digital interpretation linked to our ARIES II system. Briefly, it enables us to instantly digitize an interpretation and obtain a final product of the same type as that originating from a computerized classification.

Hans Wesbroek reports that at Lakehead University, School of Forestry, the Centre for the Application of Resource Information Systems has been established and is now being used to solve local change detection problems for some industrial clients.

Projects planned for 1985

Several projects have been suggested. One project is the examination of the Reed report to determine which forest management recommendation could be augmented by the judicious application of remote sensing. The second activity is the production of a manual of remote sensing techniques, which could be of use in the forestry community. The third activity, is the suggestion that CCRS should ask for the advice of the working group on its current and future forestry-related programs. To become an "effective" working group there should be an in-depth chance to review active and proposed CCRS forestry-related policy and projects. Approval or rejection could be a major component of the working group meetings. In such a way, the working group could then become a truly advisory group, and have significant input to the policy and programs of CCRS through CACRS.

Status

Our annual report lists several reasons why remote sensing is not being used and suggests several possible solutions a) technology transfer, b) technology development, and c) CCRS priorities. If CCRS wants public approval of its far-sighted, imaginative space-related programs, it first needs to reach the people with a better public relations program with a technology transfer emphasis, it needs to listen to all its working groups, and finally, it needs to support remote sensing activities outside of its set priorities.

5.4 HIGHLIGHTS OF THE REPORT OF THE GEOGRAPHY WORKING GROUP

Achievements during 1984

The Working Group worked on a proposal for a new task during 1984, but did not have a formal Working Group meeting.

New initiatives during 1984

A proposal for a new task--preparation of a general publication on land degradation in Canada--was developed and forwarded to the chairman of CACRS.

Projects planned for 1985

Preparation of a general publication on land degradation in Canada. Proposal has not yet been approved.

Status

The need for more information on remote sensing/interdisciplinary applications to be available to the general public was identified.

5.5 HIGHLIGHTS OF THE REPORT OF THE ICE WORKING GROUP

Achievements during 1984

Members were involved in operational and R&D sea ice and iceberg remote sensing programmes. In particular, members contributed significantly to.....

1. Bergsearch '84 - an experiment sponsored by ESRF to examine detectability of icebergs by airborne SARs (CV-580 and STAR-1) and SLARs (AES, IIP, MARS).

2. MIZEX - an international experiment in the marginal ice of Fram Strait, with six remote sensing aircraft (including CV-580), active and passive sensors.

3. AES Ice Research field programs - at Mould Bay (with NRC) for physical and microwave properties of sea ice, during March and April; passive microwave studies of freshwater ice and snow cover at St. Lawrence River, during February to March.

4. Shore-based radar experiments - DFO/McMaster University research projects at northern Baffin Island, to evaluate the effect of various radar parameters on the returns from sea ice and icebergs, and improve the display of scanning radar data.

New initiatives during 1984

AES Ice Branch: construction of modified Dash-7 begun; installation of upgraded H.F. communications between field aircraft and Ottawa; finalization of loan agreement for a second SLAR and installation on aircraft; passive microwave study of freshwater ice signatures, St. Lawrence Seaway.

Projects planned for 1985

1. Marine radar - continued work by DFO/McMaster University.

2. Search radar - Mobil testing of advanced X-band radar for iceberg detection.

3. Passive microwave study of the effect of snow on freshwater ice signatures, February to April, by AES Ice Branch.

Status

1. Operational use of commercial and government airborne SLARs and SAR, in the Beaufort Sea, Northwest Passage and on the east coast.

2. Optimization of marine radar antenna height and displays for tactical ice and iceberg surveillance purposes on drilling platforms and vessels.

3. No sensor adequate for ice thickness measurements, notably wet, rafted first-year floes at east coast locations and thicker than 2 m second- and multi-year ice in Beaufort Sea.

4. Iceberg detection and discrimination not yet perfected by either airborne or surface sensors.

5.6 HIGHLIGHTS OF THE REPORT OF THE IMAGE ANALYSIS SYSTEMS AND ARTIFICIAL INTELLIGENCE WORKING GROUP

Introduction

The first meeting of the Image Analysis Systems and Artificial Intelligence Working Group (IASAIWG) was held in Ottawa, Ontario, on January 22-23, 1985. The terms of reference of the group were discussed at length, a review of the CCRS program was presented, and an overview and demonstration of the LANDSAT-D Digital Image Analysis System (LDIAS) were provided. The meeting was highlighted by a discussion of fifth-generation computing research plans and, in particular, a proposal for a new research institute on artificial intelligence applied to resource management information systems.

Terms of Reference

Scope and Function:

The Working Group on Image Analysis Systems and Artificial Intelligence is concerned with the development of image analysis systems and research and development in artificial intelligence as they apply to resource information systems. The emphasis is on enhanced effectiveness and efficiency of information extraction from remotely sensed data.

Short-Term Goals:

The Working Group will pursue the following short-term goals, to be achieved by the end of its first year of operation:

1. To prepare an initial assessment of work in artificial intelligence, as it pertains to resource information systems and image analysis.

2. To prepare a set of prioritized recommendations for research and development in Image Analysis and Artificial Intelligence.

Actions Items from the Meeting

1. Establish Sub-Working Group on UNIDSK image database standardization.

2. Make a trip to Japan to assess their progress and organization with respect to Fifth-Generation Computing.

3. Distribution of minutes to all members.

4. Prepare draft of institute proposal for IASAIWG members' comments and revision.

5. Arrange tutorial on expert systems and logic programming at CCRS, open to IASAIWG members.

5.7 HIGHLIGHTS OF THE REPORT OF THE IMAGE ANALYSIS SYSTEM USERS WORKING GROUP

The first meeting of the Image Analysis System Users Working Group was held in St. John's, Newfoundland, on August 15, 1984. The objectives of the group were reviewed, and a list of topics relevant to the goals was identified and discussed. A presentation was made to the group by Dr. Bernie Grush on the products and future direction of Perceptron Ltd.

The priority items identified and considered included:

1) Interfacing remote sensing and geocoded databases;

2) The need to research and develop spatially oriented techniques to make better use of the next generation of high-resolution satellite and airborne sensor systems;

3) Expert systems to assist in the remote sensing-geographic database link and in change analysis and the simplification of difficult user tasks;

4) The emergence of powerful microcomputers with fully integrated high-resolution colour displays and their considerable impact on the availability of low-cost remote sensing imaging systems.

A list and brief description of image analysis systems in Canada was prepared. It currently describes 40 systems.

Recommendations relating to CCRS research priorities included the critical importance of linking remote sensing output products to geographic information systems, the importance of MEIS and the need for geometrically corrected data that will interface with geographic databases, the need for spatial classifiers to handle the data from the next generation of satellite and airborne systems, and the importance and need for EXPERT systems to be integrated in the next generation of our image analysis systems. CCRS was asked to provide the effort necessary to ensure the rapid development of micro-based image analysis software through co-operative development programs with the private sector. It was also suggested that CCRS should quickly conduct a study of laser disk technology with the objective of producing a low-cost data media product to be used to input remote sensing data to microcomputers.

5.8 HIGHLIGHTS OF THE REPORT OF THE OCEANS WORKING GROUP

Achievements during 1984

The CACRS Working Group on Oceanography held a meeting in St. John's, Newfoundland on August 13, 1984 in conjunction with the 9th Canadian Symposium on Remote Sensing. Members of the Working Group reported on their various interests and concerns in the field of oceanic remote sensing. Projects ranged from using Nimbus-7 SMMR data for mapping wind, water vapour and ice over the ocean to the testing of an airborne laser system for hydrographic surveying. The members recommended that the 10 bit AVHRR data from the Prince Albert Station should not be decimated to 8-bit data when translated to CCTs. They also felt that CCRS should be placing greater emphasis on oceanic applications. The final recommendations of this Working Group are presented elsewhere in this report.

On December 19, 1984 senior officials of Canadian government departments were briefed on the NOAA proposal for the integration of domestic and foreign satellite data into an Operational Satellite Oceanic Information Distribution System. Mr. John Sherman, Chief, Oceanic Sciences Branch of the National Environmental Satellite, Data and Information Service, NOAA, spoke on future satellite-derived ocean information products for the civilian marine community. Dr. Stan Wilson from NASA's Oceanic Processes Branch addressed the subject of oceanographic research from space. A number of publications related to the subject matter of these talks were distributed to attendees.

New initiatives during 1984

The Working Group on Oceanography, under Dr. Jim Gower, completed its work at the end of 1984 and a new group was constituted on December 19, 1984 as the Oceans Working Group under Mr. G. Holland, Director of Ocean Science Affairs, DFO. The new Working Group, consisting primarily of membership from federal line departments, was given the very specific task of reporting on domestic and foreign oceanic satellite systems for the next decade. This Canadian plan for satellite oceanography is required by August 1985, at which time a broader Working Group membership will be considered.

The Bedford Institute of Oceanography has acquired a new image processing system which will be used jointly with Dalhousie University to develop ocean productivity applications for the large existing data base of satellite optical data (ocean colour, VIS and IR). The University of Miami oceans image analysis software has been installed on the BIO system.

RADARSAT has expanded its efforts in the area of oceanic microwave remote sensing with the creation of a small oceans applications group. The Cape Sable Experiment carried out by this group in conjuction with the Bedford Institute of Oceanography should provide useful information on the limits of detectability of oceanic phenomena by SAR.

Projects planned for 1985

a) To report on the oceanographic satellite systems* that will be in place in the 1984-2000 time frame, to examine how such systems could be of benefit to Canada and to recommend options for Canadian involvement. The infrastructure that will be needed in Canada to support such an involvement is to be included.

b) To recommend the way in which RADARSAT can best contribute to the above observation system.

* "System" includes the oceanographic satellites, the data links, the processing facilities, the distribution network for the products, and the services to the ultimate users.

Status of remote sensing in oceanography

This subject is being addressed in the Oceans Working Group's report on future oceanic satellite activities. At the present time, access to satellite data is often confusing, difficult, and slow. A carefully-thought-out data management plan for the new generation of satellites is essential.

5.9 HIGHLIGHTS OF THE REPORT OF THE SATELLITE TECHNOLOGY WORKING GROUP

The Working Group was re-organized this year to include the wider membership of Canadian companies involved in space remote sensing. The group reviewed two areas of space technology that are important to Canadian remote sensing plans: synthetic aperture radar (SAR) and in-orbit servicing. Canada has developed a competence in satellite SAR data processing and airborne SAR systems and is now extending it to include space hardware through development of multi-beam antennas and high-power amplifiers.

In-orbit servicing will greatly change the way satellite remote sensing is performed. By changing instruments and refuelling orbiting platforms the costs of these systems will be reduced. RADARSAT will be designed so that it is serviceable from the shuttle.

The members were asked to consider how these future technologies will affect their companies' activities and to collaborate in an economic impact assessment study of the RADARSAT project.

The members also agreed to produce a report on their strategy for Canadian industry involvement in space remote sensing.

5.10 HIGHLIGHTS OF THE REPORT OF THE WATER RESOURCES WORKING GROUP

Achievements during 1984

The Working Group held one business meeting in 1984, at which members reviewed activities in water resources remote sensing across Canada. Data retransmission via satellite is still of greatest interest to operational water agencies, although many of the planned DCP networks are approaching their maximum size. The Proceedings of the 2nd Canadian Workshop on DCP Networks, co-sponsored by the Working Group, was published and is available from the Canadian Climate Centre, Atmospheric Environment Service. The Working Group reviews the status of developments in this field, but no longer takes a lead role in co-ordinating inter-agency activities. The scientific meeting planned for 1984, in conjunction with the planned Streamflow Forecasting Workshop was cancelled because the workshop was postponed until 1985.

New initiatives during 1984

Two new projects were initiated at the fall business meeting. A plan of action was developed for preparing a list of Canadian private-sector companies and their expertise in the field of remote sensing applications for water resources. Personal contacts will be made on a regional or local basis across the country. All information will be requested on a voluntary basis. To avoid compiling an extensive list of forms on the basis of possible capability, questions will be related only to demonstrated capability. Twelve questions have been prepared as a guide for members to follow.

Members also reviewed two CCRS slide sets on water resources applications. It was felt that more current examples could be included in the CCRS file. Members will be reviewing their own slides or those of their agency for examples that might be included.

The focus of the working group is shifting to the application of remotely sensed data in hydrological models used in Canada. A list of models used by agencies has been initiated. Using this list, the Working Group will review the applicability of remote sensing technology.

Projects planned for 1985

The Working Group will hold a scientific session in Montreal in conjunction with the Streamflow Forecasting Workshop. Papers on the application of remote sensing in hydrological forecasting will be presented by Working-Group members. It is expected that the meeting will provide a useful dialogue on the use of remote sensing for this purpose. Problems and limitations should be identified.

The report on the activities of consultants will be prepared for discussion at the 1985 business meeting. Slides of remote sensing applications will be reviewed; an accompanying text describing each application will then be prepared. The feasibility of preparing a videotape of the collection will be assessed.

Status

Many of the applications in the water resource field use data from systems other than LANDSAT, in particular, the NOAA and GOES weather satellites and NIMBUS. Ready access to these data is necessary if applications are to be expanded, or alternatively, if a central agency provides analyses as required by users. The ultimate questions of "who pays" and "how much" are closely linked.

There is a need for continued demonstration of applications and clear definition of benefits to be gained from using remotely sensed data. The latter is one of the biggest obstacles to be overcome at the moment. The Working Group will continue its efforts to address this problem. However, rigid cost-benefit analyses do not always fare well in the water resources field.

The Working Group will continue to meet its objectives through its projects planned for 1985.

6.0 HIGHLIGHTS OF THE REPORTS OF THE PROVINCES AND TERRITORIES

6.1 HIGHLIGHTS OF THE REPORT OF THE INTERPROVINCIAL/TERRITORIAL ADVISORY SUB-COMMITTEE OF CACRS (IPTASC)

TERMS OF REFERENCE

Objectives

1. To ensure that remote sensing technology, data resources and developments in methodologies of application, are made available to resource managers and scientific investigators in all Provinces and Territories of Canada.

2. To ensure that the needs of regional users of remote sensing are reflected in the national program.

   NOTE: "user" is an individual or agency actively engaged in a remote sensing role or having a jurisdiction related to present or potential remote sensing activities.

Functions

1. To facilitate an exchange of information originating in international, federal and provincial/territorial remote sensing programs, among the provincial/territorial remote sensing representatives.

2. To facilitate the mutual assistance of provinces and territories regarding the technical and organizational problems of their respective remote sensing programs.

3. To encourage the efficient co-operation between federal and provincial/territorial efforts to better serve regional remote sensing practitioners and potential users.

4. To facilitate the process of providing the federal remote sensing program with information as to use made regionally of remote sensing resources and the benefits derived from such use.

5. To make recommendations regarding proposals for current and future changes in or additions to the federal remote sensing program.

6. To prepare and present a report, that includes recommendations, to each CACRS meeting without prejudice to each provincial or territorial report to CACRS.

7. To review the above Terms of Reference annually.

Membership

IPTASC is a body of representatives appointed to CACRS on the recommendation of the Provinces and Territories.

Each member shall be entitled to one vote on each issue. For voting purposes a quorum shall be of four attending members. Up to, but not later than, four weeks after distribution of the minutes of a meeting attended by only four members, non-attending members may object to the Chairman on an issue with which they do not agree. If agreement between the Chairman and objecting members is not reached, the issue shall be resolved by a mail-in vote of all members.

Each representative may invite someone to any IPTASC meeting in his/her stead. The alternate has the right to speak to and vote on any issue. In addition, the representative may invite someone to accompany him/her to any IPTASC meeting as an observer. The observer may speak to any issue, but does not have the right to vote. The selection of alternate and observer is, in all respects, at the discretion of the representative.

Chairmanship

IPTASC elects both a Chairman and Vice-Chairman to hold office for two years. At the end of that period, the Vice-Chairman becomes Chairman automatically, and a new Vice-Chairman is elected. Elections are held only at an annual meeting or when a vacancy occurs.

1984-85 Meetings

IPTASC members met in Ottawa on April 16, 1984 and at Arnprior on April 18, 1984 in conjunction with the annual meeting of CACRS. During these meetings, the following recommendations were developed.

IPTASC recommended that CCRS reopen talks with NOAA to gain reception rights over eastern Canada for LANDSAT at the new SPOT ground station.

IPTASC reassured CCRS of its support of the inclusion of a VIR sensor on the RADARSAT system. Regarding spectral and spatial resolution of the sensor, IPTASC submitted detailed recommendations to the RADARSAT office.

It was suggested to CCRS that the possibility

of designing "Video Games" to promote satellite imagery be examined.

IPTASC recommended that Dr. L.W. Morley be appointed as an honorary member of CACRS in recognition of his service to remote sensing.

IPTASC also met on November 6, 1984 to review the 1985 Annual Meeting program and made the following additional recommendations.

The IPTASC recommendation about a video game contest was discussed, and members suggested that CCRS handle it as an unsolicited proposal or a student-oriented project.

IPTASC requested that CCRS, in co-operation with provincial and regional centres, conduct TM data users' workshops in various parts of Canada beginning in autumn 1985. Also, IPTASC recommended that the Image Analysis Systems and Artificial Intelligence Working Group meet as soon as possible, and that the Agriculture Working Group hold open workshops on agricultural topics.

IPTASC requested that provincial and regional centres be given copies of TM images for public relations purposes, since the product and its availability are not yet widely known. Also, IPTASC members expressed a strong interest in SPOT data and are anxious to receive some as soon as available.

On November 6, 1984 IPTASC members elected Hervé Audet as the new Vice-Chairman; however, M. Audet resigned from the Government of Québec in March 1985 and Mr. Ivan Ford was elected Vice-President on March 26, 1985.

6.2 HIGHLIGHTS OF THE REPORT OF THE PROVINCE OF ALBERTA

Airborne Remote Sensing

The Canada Centre for Remote Sensing carried out one task in Alberta.

Spaceborne Remote Sensing

The private sector, educational institutions and government agencies utilized spaceborne data for varied multidisciplinary applications, particularly in digital versus hard copy format.

Alberta Remote Sensing Center

The Alberta Remote Sensing Center advised and assisted Alberta users in the acquisition, application and analysis of remotely sensed data. The Center, user-oriented, did not carry out internal research or projects.

The Center's ARIES II digital analysis system was almost completely utilized by out-of-Center users for their own projects. Assistance in its operation was given by the Center's staff.

The Center supported and funded remote sensing demonstration projects to assess remote sensing technology in new applications. All of the 1984 demonstration projects were contracted to private industry or universities:

- Model for a Winter Wheat Crop Information System Based on Resource Satellite Data. Dr. P.H. Crown, University of Alberta, Edmonton.

- Evaluation of Remote Sensing to Monitor Areal Extent and Severity of Sulphur Related Stress in Vegetation in Central Alberta. M.D. Thompson, Intera Technologies Ltd., Calgary.

- Evaluation of LANDSAT Imagery as a Wildlife Management Tool. O. Niemann and G. Langford, Geo-Spatial Research Corp., Edmonton.

- LANDSAT Imagery in Monitoring and Mapping Land Use/Cover Changes in Rural Alberta. G. Berman, White Earth Remote Sensing, Edmonton.

- Historical LANDSAT Imagery for Monitoring Mixed Grass Prairie Rangelands in Alberta. C. Pearce, University of Calgary, Calgary.

The Center (in co-operation with Alberta Energy and Natural Resources) lent field staff assistance to CCRS in their 1984 Thematic Mapper - Rough Fescue Rangeland Project.

Training

The Universities of Alberta and Calgary offered graduate and undergraduate courses in remote sensing. Other universities, technical institutions and colleges have introduced remote sensing courses into their programs. Many such courses, particularly in north-central Alberta, incorporate visits to the Center.

In its efforts to enhance Albertans' use of remote sensing for resource management, the Center continued its technology transfer role. The recipients include multidisciplinary agencies from private industry, education and government.

In co-operation with the Faculty of Extension, University of Alberta, the Center conducted the Twelfth Alberta Remote Sensing Course, with participants from across Canada.

To meet increased interest in digital image analysis, the Center conducted 13 one-day ARIES familiarization workshops in 1984.

A LANDSAT Rangeland Workshop was held in Medicine Hat for government and private range managers.

Two workshops on LANDSAT Imagery for Forestry were jointly conducted by CCRS, the Northern Forest Research Centre and the Alberta Remote Sensing Center.

An instructional audio-visual slide-tape package on Forestry Applications of Remote Sensing was produced by R.T. Morton, Silvacom Computer Analysis Ltd., Edmonton, for instructional use.

Lectures, briefings and displays, in-Center and around the province, were given to industry, government and university/school groups.

Committee work continued on the:

10th CANADIAN SYMPOSIUM
ON
REMOTE SENSING

EDMONTON, ALBERTA
5-8 MAY, 1986

6.3 HIGHLIGHTS OF THE REPORT OF THE PROVINCE OF BRITISH COLUMBIA

The acquisition of all provincial aerial photography was again carried out under contract, with a total of 16,746 black-and-white photos of various scales obtained over 34,455 line km during the past summer. The operational use of large-scale photography has continued, primarily for multiphase sampling and for forest classification. B.C. Research carried out a pilot project using 35 mm aerial photography to identify leachates from landfilling operations in the lower mainland. Pacific Forest Research Centre projects included the use of airborne photography to study damage caused by root disease in portions of the Greater Victoria Sooke Lake Watershed Forests.

The Institute of Ocean Sciences is continuing work on a new type of optical imager to improve mapping of sea surface chlorophyll concentrations.

The Planning and Inventory Branch of the Ministry of Forests has recently acquired a digital image analysis system which comprises a Gould DeAnza IP 6400 image processor with CIAS software and which is hosted on a VAX 11/780 minicomputer, with LDIAS software from CCRS. Initial emphasis is being placed on updating forest depletions. Individual map sheets are identified by neat line registration and after multi-temporal classification, image enhancements, sub-pixel sampling and rotation procedures, images of individual maps are loaded to the colour raster station. This allows the overlay of map images with map design files for any selected topographic detail. Digital elevation models are being derived for a significant area of the province, using data acquired from the Federal Government. These models will be incorporated into the forest inventory data base to be used with both the digitized maps and the satellite imagery.

The Ministry of Environment has established a Thematic Mapper (TM) wildlife habitat project in conjunction with several agencies.

B.C. Research acquired an image processing system with an ADAGE 3006 interactive display hosted on a VAX 11/780 computer. Software includes EASI, a user interface, and PACE, an applications package, both from Perceptron Computing Inc. This system is supporting several projects related to the analysis of LANDSAT-5 TM data.

The Pacific Forest Research Centre (PFRC) has completed a co-operative project with the Saskatchewan Forest Service in updating forestdepletions using MSS digital data. A co-operative project with the B.C. Ministry of Forests on the assessment of log debris on Williston Lake using MSS digital data has been completed and PFRC is continuing work in digital optical microscopy and in digital electrophoresis.

Remote sensing teaching and research continues at the University of British Columbia in computer science, forestry, geography, oceanography, soil science, astronomy, geophysics, and electrical and civil engineering. A two-day workshop was hosted by UBC in June 1984. Research by both faculty members and graduate students contines to involve numerous aspects of digital image analysis, such as the estimation of solar irradiance from the Earth by satellite; the study of ice arching in the Beaufort Sea; the digital evaluation of forest cover maps; and the determination of forest canopy density via digital image analysis.

The Institute of Ocean Sciences evaluated satellite data with their Ikonas/DEC 1134 image processing system. NOAA AVHRR imagery was rectified and used to study thermal patterns off the B.C. coast.

MacDonald Dettwiler and Associates is currently developing MERIDIAN, a second generation image analysis system that encompasses the MDA Geocoded Image Correction System, full image analysis functionality and an optional link to INTERGRAPH geographic information systems (GIS). Other projects include the development of a system to automatically produce digital terrain models from stereo imagery (e.g. SPOT satellite), the development of a two-way link between an image analysis system and an INTERGRAPH GIS, and advanced image classification research.

PAMAP Graphics has participated in the B.C. Ministry of Forests' interface between image analysis and mapping. Software has been developed that converts vector map data to a grid, or raster format for analysis and colour raster display. Grids that result from analysis can be converted back to vector format. This capability has also been incorporated in the microcomputer mapping software called GEOMAP.

6.4 HIGHLIGHTS OF THE REPORT OF THE PROVINCE OF MANITOBA

Achievements during 1984

The Technology Enhancement Program started in December, 1982 was established by a Memorandum of Understanding between the Department of Natural Resources, Manitoba and the Department of Energy, Mines and Resources, Canada. The program came to an end in June, 1984 after the following seven projects were carried out.

1. Crop Data Monitoring
2. Forest Fuel and Wildfire Mapping
3. Inventory of Moose Habitat
4. Valley River Watershed Current Land Use
5. Vegetation Cover on the east side of Lake Winnipeg
6. Mapping Rangeland in Agro-Manitoba
7. Monitoring Irrigation Activity on the Assiniboine Delta Aquifer

An advisory committee made up of representatives from the branches and agencies involved in the program evaluated the project results. Based on their findings, it was recommended that there be an ongoing remote sensing program to utilize the technology. With Treasury Board approval the Department of Natural Resources made funds available for the purchase of an ARIES II Image Analysis System for the Manitoba Remote Sensing Centre to continue providing the service.

New initiatives during 1984

During 1984 several projects got underway to test new applications. The LANDSAT Directorate, Canada Centre for Remote Sensing, Statistics Canada and Agriculture Canada were involved in developing an operational method for rural land-use change monitoring based on satellite and airborne data. The University of Manitoba, Earth Science Department continued to carry out research on the integration of geophysical data as applied to seismology and satellite multispectral data. A project designed to derive accurate and timely crop area estimates from LANDSAT data for all of agro-Manitoba was carried out. This was a co-operative venture with Manitoba Agriculture, Statistics Canada, and the Manitoba Remote Sensing Centre. There was also a canola-rapeseed simulation study carried out to determine to what extent this crop could be classified without the aid of ground information or by the analyst without knowledge of local conditions. Personnel from the Maritime Mammal Division of the Department of Fisheries and Oceans, working out of the Freshwater Institute in Winnipeg were busy developing remote sensing techniques for marine mammal surveys.

Projects planned for 1985

The Manitoba Crop Area Estimation Project will be carried out by Manitoba Agriculture, the Manitoba Remote Sensing Centre and Statistics Canada. The area of interest will be the twelve crop disticts of agro-Manitoba, an area covered by approximately eight LANDSAT scenes. The crops of interest will continue to be canola-rapeseed, cereal grains, and summer fallow. Crop signatures and classifications will be carried out in Manitoba with the sample selections and the statistical work being done by Statistics Canada. This is a full scale multi-crop project to generate area information in a timely, accurate, and reliable fashion.

Based on the results of a peatland project carried out in The Pas area, the Manitoba Department of Energy and Mines has requested that further work be carried out. A team made up of a geologist, a peatland ecologist and a remote sensing technologist will carry out a study in the southeast area of Manitoba. The objectives will be to map peatland at a level of detail greater than that of the first project and to compare costs and accuracy with those of present inventory methods in use.

Projects will also be carried out to utilize remote sensing techniques to provide estimates of areas for specialty crops that are considered to be significant by Manitoba Agriculture. Some of these crops are corn, beans, peas, mustard and sunflowers.

At the request of the Parks Branch, Manitoba Department of Natural Resources, work will proceed at the Remote Sensing Centre toward developing a thematic data base for Hecla Provincial Park. The objective is to create a bank for the storage and retrieval of information to facilitate more efficient park planning functions.

Status

With the successes experienced on project work carried out during the term of the Technology Enhancement Program, other agencies that were not involved are showing a greater interest in remote sensing technology. The Remote Sensing Centre is moving from a co-ordinating function to an operational role. If the number of requests for project work continues to grow, the present capacity to produce will be far exceeded by the demand for service.

6.5 HIGHLIGHTS OF THE REPORT OF THE PROVINCE OF NEW BRUNSWICK

Spaceborne Remote Sensing

A number of Technology Enhancement projects were obtained through 1984. One project estimates the snowcover on 66 sub-basins of the Saint John watershed in order to modify the input to the flood forecast model. After the 1984 season, the project is expected to be adopted by the Flood Forecast Centre in Fredericton, marking the successful completion of this project as a Technology Enhancement project.

Two watersheds were investigated in the Moncton area (Turtle Creek and Irishtown) under the Watershed change detection project. A methodology was developed that compared the biomass ratios over time.

The project aimed at improving the update of cut area estimates by the Timber Management Branch (D.N.R.) continued during 1984, focussing mainly on locating cuts and their associated boundaries.

Work continued on a project aimed at providing a description of the potato crop rotation practices in the Grand Falls area. It is expected that the methodology developed there will be used in a quasi-operational way in 1985 in other potato growing areas of the province.

The Canadian Forestry Service continued its study of spruce budworm defoliation. Detailed studies were undertaken to compare the reflectance characteristics of both healthy and defoliated trees of a variety of species.

Airborne Remote Sensing

A total of 8,000 line kilometers of 9 by 9 format color photography (1:12,500) were taken in the extreme southern portion of the province around Charlotte, St. John and Kings Counties, and in the Gloucester-Northumberland county boundary. This work represents the fourth year of a five-year project to acquire complete provincial coverage.

New Initiatives

Canadian Forestry Service personnel are investigating the possibility of a trial U-2 flight to demonstrate the feasibility of using this technique for budworm damage assessment.

A MEIS flight is planned in 1985 to evaluate the potential of this scanner for the delineation of current spruce budworm defoliation.

Courses and Training

A workshop co-sponsored by the New Brunswick Remote Sensing Committee, the University of New Brunswick, and CCRS was given in February 1984, aimed at providing geological users with the necessary tools to be able to use digital products and analysis in their work.

Courses in the fundamentals of remote sensing as well as post-graduate courses in digital analysis continue to be given at the University of New Brunswick.

6.6 HIGHLIGHTS OF THE REPORT OF THE PROVINCE OF NEWFOUNDLAND

There has been a renewed interest in remote sensing in Newfoundland over the past year. A number of provincial resource management agencies have expressed interest in remotely sensed data as a source of information for their resource monitoring and planning programs. The Department of Development of the Government of Newfoundland and Labrador and the Canada Centre for Remote Sensing have met with these agencies to determine whether their needs can be met with currently operational remote sensing applications and, subsequently, by the applicability to the CCRS Technology Enhancement Program.

CCRS and the Department of Development have held discussions and are currently planning a Technology Enhancement Program for Newfoundland. Under this program a number of projects will be conducted with resource agencies in the Province to demonstrate the utilization of remotely sensed data as a source of resource information. The Department of Development will be the coordinating body for the projects and CCRS will provide the expertise for data manipulation.

A 2-day workshop was held in St. John's in November, 1984, sponsored by CCRS and the Department of Development. The workshop was attended by 33 representatives from educational institutions and various levels of government. The main objective of the workshop was to introduce the potential Technology Enhancement Program participants to remote sensing methods, sensors, platforms and their operational uses in resource management. The workshop was very well presented and most participants felt it was extremely useful.

The hosting of the 9th Symposium on Remote Sensing in St. John's during August, 1984 was a major highlight in remote sensing in Newfoundland this year. The symposium was attended by approximately 180 participants. About 100 papers were presented in poster and plenary sessions. The social events were well attended and indications are that the participants thoroughly enjoyed the symposium. The major benefit to Newfoundland was that it allowed many people who have an interest in remote sensing in this Province the opportunity to attend, an opportunity that they normally would not have had. Because of the symposium a greater awareness of remote sensing now exists within the Province.

In conclusion, during 1984 significant progress was made in the development of remote sensing potential in Newfoundland.

6.7 HIGHLIGHTS OF THE REPORT OF THE PROVINCE OF NOVA SCOTIA

The Lands Directorate is involved in wetlands study using high-altitude photography. The monitoring of land in the "Rural Area Component" is an increasing priority for the agency.

The Bedford Institute of Oceanography has installed a new Image Analysis System on a VAX 750 computer. Applications in ocean sensing will be pursued. Large quantities of data tapes from NOAA have been acquired. Over 40 scientists have been trained on the system.

The First Atlantic Symposium on Remote Sensing and Geographic Information Systems will be held August 16 and 17, 1985.

The Department of Lands and Forests is continuing with its forest clearcut inventory from MSS and DICS data. Plans have been made to acquire a Geographic Information System in the near future.

The Nova Scotia Land Survey Institute continues to expand resources available to its Remote Sensing Diploma program. A DIPIX, ARIES II workstation based on a new VAX 785 computer has been ordered. This is in addition to the existing stand-alone system, which has been upgraded to run on a PDP 11/73 processor. In all, over $1 million has been committed this fiscal year to hardware and software for use in the REMOTE SENSING and related programs. Funding, equivalent to 66 scholarships valued at from $10,000 to $20,000 each, is available for students gaining acceptance to these programs.

Atlantic Canada Airborne Sensing Inc. has expanded the level of activity over the previous year. Of special note is the work being done in the coastal and offshore areas.

6.8 HIGHLIGHTS OF THE REPORT OF THE PROVINCE OF ONTARIO

Gregory Geoscience Ltd. continued to perform nationwide LANDSAT-based change detection for topographic map revision: 5000 1:50,000 scale map areas have been assessed to date. The average cost of providing revision information is $5,000 per 1:250,000 scale map sheet, or 21¢ per sq. km.

Dipix Systems Ltd. shipped its 100th ARIES image analysis system. The company currently accounts for approximately 20% of commercially provided image analysis systems in the world.

The Ontario Centre for Remote Sensing (OCRS) continued developmental projects in digital LANDSAT-based peatland inventory, general and agricultural land use mapping and wetland mapping in the Hudson Bay-James Bay Lowland.

OCRS refined and developed colour-infrared negative processing and printing techniques, implemented software for quality control of CIR negative photography, and prepared specifications for operational CIR photo acquisition.

Professor J. Vlcek of the Faculty of Forestry, University of Toronto, developed a four-video camera system for the acquisition of multispectral airborne video data.

Dendron Resource Surveys Ltd. is continuing research into applications of airborne laser profiling.

An Industrial Advisory Committee was established to advise the Ontario Government on remote sensing policy as it affects the private sector.

An Interministerial Remote Sensing Advisory Committee was established to determine how remote sensing can benefit the programs of the member ministries and how OCRS can help them obtain the services they require.

Data from new sensors was evaluated:

- the Centre for Research in Experimental Space Science at York University analyzed airborne MEIS II and MSS data for a geobotanical investigation;
- OCRS assessed MEIS II and MSS data for boreal forest classification;
- OCRS compared LANDSAT TM and MSS data for peatland mapping:
- the Ontario Agricultural College of the University of Guelph studied MEIS II data for the interpretation of soil characteristics;
- the University of Waterloo conducted projects in the digital analysis of airborne MSS and MEIS II data, as well as TM, CZCS and radar data.

OCRS gave five short courses in remote sensing application, as well as special workshops and seminars for universities, companies and visiting scientists from other countries. The University of Waterloo, with assistance from OCRS, conducted its annual remote sensing course. Dipix System Ltd. gave operating and programming instruction on its ARIES III system to approximately 70 trainees. Northway-Gestalt Corporation (now Northway Map Technology) gave client seminars in digital mapping. Dr. A.F. Gregory, President of Gregory Geoscience, gave lectures at seven Ontario universities under a joint program of the Ontario Assocation of Remote Sensing and the Canadian Remote Sensing Society.

6.9 HIGHLIGHTS OF THE REPORT OF THE CENTRE QUÉBÉCOIS DE COORDINATION DE LA TÉLÉDÉTECTION

Events and activities of 1984

A new member, Pierre Laframboise, joined the CQCT as project manager. The team now comprises three persons.

The following projects were completed or continued in 1984 by the CQCT or other sectors of the Québec government:

- Mapping of the forest biomass in New Québec (Service d'inventaire forestier, MER).
- Mapping of burned-over areas using DICS images (Service d'inventaire forestier, MER).
- Development of crop identification methods using TM images (Service des analyses d'impact sur le milieu agricole, MAPA).
- SPOT simulation to study the opportunities for large-scale forestry mapping (Service d'inventaire forestier, MER).
- Use of remote sensing in mineral exploration in the Labrador trough (Service des programmes d'aide à l'exploration, MER).
- Assessment of spruce budworm damage using multispectral scanners (Service d'enthomologie et de pathologie, MER).

The Québec-France remote-sensing exchange program was continued, with 14 Quebecers travelling to France and 8 French visitors coming to Québec.

New initiatives in 1984

- A new program on the use of spaceborne remote sensing for the inventory of peat deposits; several methodologies were evaluated (Service de la géologie, MER).
- Geological studies: mapping of lineaments and macroscopic structures (Service de la géologie and Service des programmes d'aide à l'exploration, MER).
- Pilot project on the mapping of uncultivated land using TM images (Service des analyses d'impact sur le milieu agricole, MAPA).
- Development of an interactive digital interpretation system in collaboration with the Laurentian Forest Research Centre.
- New project proposed under the preliminary SPOT assessment program (PEPS); the project was approved by the selection board.
- Québec government grant to the Town of Gatineau for the construction of an access road to the SPOT satellite station.

Projects planned for 1985

We plan to continue with the above work on the following subjects: peat bogs, SPOT simulations for forestry mapping, burned-over areas, spruce budworm, macroscopic structures, and geological lineaments. We also plan to start a project on the development of an operational method for mapping uncultivated land using TM images (Service d'analyse d'impact sur le milieu agricole, MAPA) and a project for the thermographic remote sensing of forests undergoing regeneration after fire, logging or reforestation (Service de recherche, MER).

Overall situation

The CQCT's approach is always to carry out projects jointly with client services (the names of which are given in parentheses in each case). Private firms also play a role in most projects, either as consultants or as service suppliers. Digim (1983) Inc, Le Groupe Dryade Ltée, and Pierre Gignac & Associés all carried out service contracts. Universities and research institutes were also involved in some projects.

In 1984, the CQCT made a firm commitment to take advantage of new satellite technology, in keeping with the spirit of the 1981 symposium held in Montréal on the use of the next generation of Earth observation satellites.

The tripartite agreement on SCANIQ expired in December 1984; a new agreement will enable MER to share a revised SCANIQ system with the Laurentian Forest Research Centre.

6.10 HIGHLIGHTS OF THE REPORT OF THE PROVINCE OF SASKATCHEWAN

Airborne

CCRS flew 4 missions at 3 sites in Saskatchewan in conjunction with RADARSAT. MEIS, SAR, false-colour photography, LANDSAT, NOAA, SIR-B and ground data were collected in June, July, August and October at Melfort, Outlook and Swift Current (See CCRS and Agriculture reports).

Two Saskatchewan companies are providing agricultural information to farmers for fertilizer applications. One company has, however, been taken to court over the data supplied. A Prince Albert company is providing thermal infra-red data for fire fighting.

A new company is developing a system to integrate fertilizer application requirements with radio controlled position (in a field), DTMs (for slope and aspect), aerial photography and soil type.

Satellite

Seven demonstration projects are using either LANDSAT or NOAA data (part of the CCRS Technology Enhancement Program). The demonstration projects are deer, moose and caribou habitat studies, fire and clearcut inventory, depression storage for spring flood prediction, salinity detection in irrigated areas and field boundaries for crop insurance. These seven projects are being carried out by 5 provincial government departments or agencies (Departments of Agriculture and Parks and Renewable Resources, Saskatchewan Water Corporation, Saskatchewan Crop Insurance, and the Saskatchewan Research Council). The Technology Enhancement Program is a joint program between CCRS and the Saskatchewan government and is administered by CCRS and Saskatchewan Research Council (SRC). The DIPIX equipment and CCRS employee are located at SRC in Saskatoon. The project personnel are located in Regina, Outlook, Saskatoon, Hudson Bay and Prince Albert with the study areas located near Regina, Outlook, Estevan, Swift Current, La Ronge and Wollaston.

Training

The CCRS Technology Enhancement Program has provided 6 seminars on general remote sensing, habitat mapping, agriculture, rangeland, geology and water resources. Three digital application courses have been provided by CCRS and SRC to 15 government employees. Seven university students have also been trained on the DIPIX system. Jack Mollard, Jeff Whiting, Dr. Crane, Dr. Fung, Dr. Wacker and Dr. Lackie are teaching remote sensing courses.

Co-ordination

Three new committees to co-ordinate the Saskatchewan Technology Enhancement Program (STEP) have been started. These are a Steering Committee, a Users Advisory Group and an SRC Advisory Group. Some 300 people have received Saskatchewan's first remote sensing newsletter.

6.11 HIGHLIGHTS OF THE REPORT OF THE YUKON TERRITORY

A variety of remote sensing applications were conducted in the Yukon during 1984/85 by several government and non-government agencies.

The Yukon Department of Renewable Resources (Land, Parks and Resources Branch) utilized 1:1,000,000 LANDSAT colour transparencies to assist in the delineation of ecodistrict boundaries of the southwestern Yukon. Reconnaissance-level forest type mapping using LANDSAT 1:250,000 images and 1:1,000,000 transparencies was conducted by the Forestry Branch, DIAND, in areas of the Yukon where recent airphoto coverage was unavailable. The Canadian Wildlife Service (Environment Canada) mapped late spring (1984) snowbed distribution as an indicator of plant communities that are important to caribou on the north slope of the Yukon. Black-and-white 1:1,000,000 LANDSAT images were used for this project.

The University of Waterloo is investigating the significance of Digital Elevation Model (DEM) variables on LANDSAT MSS data analysis in the Aishihik and Bear Lakes areas of the Yukon.

The U.S. Fish and Wildlife Service (Fairbanks, Alaska), associated with the Alaska North Slope Wildlife Refuge, is using digital MSS data to identify caribou habitat types for the entire range of the Porcupine Caribou in the Yukon and Alaska. The computer addition, satellite tracking (Tyros) of radio-collared caribou is being researched to assist in the identification of habitat types used by the caribou.

7.0 HIGHLIGHTS OF THE REPORTS OF THE SPECIALTY GROUPS

7.1 HIGHLIGHTS OF THE REPORT OF THE ATMOSPHERIC ENVIRONMENT SERVICE

Achievements during 1984

The Atmospheric Environment Service (AES) continued to receive, process and distribute data from both geostationary and polar-orbiting meteorological satellites. A system to archive data from the GOES system was installed. Operational archiving of data will begin when GOES-E is replaced.

The processing and use of TOVS data was advanced. Of particular interest was the use of these data for the forecast of freezing rain.

Products from the RAINSAT project, in which weather radar is used to "calibrate" data from GOES, were tested in operational weather offices, although their quality was lower than expected because of the failure of GOES-E. The use of RAINSAT information as input to a fine scale numerical prediction model gave encouraging results.

The partnership between AES and EMR in the RADARSAT project was formalized and system definition and design studies continued. The design and procurement of a new ice reconnaissance centre and highly instrumented aircraft progressed in 1984.

Projects planned for 1985

The reception station for NOAA data in Downsview will be replaced. A similar station will be purchased for Edmonton.

GOES Data Collection System data reception will become operational in Downsview and Vancouver.

A contract will be let for the design and installation of new equipment to allow continued reception of GOES data in Downsview and Vancouver when the data format is changed in 1986.

The DASH-7IR aircraft, equipped for ice reconnaissance, will be delivered in September, 1985.

AES will complete its part of RADARSAT Phase B studies.

Status

Remotely sensed data have received acceptance as an indispensable part of the meteorological data acquisition system. In addition to the use of images in briefing and weather analyses, quantitatively processed data is becoming more widely used in numerical models and forecast preparation.

Research and development provides new data products for operational evaluation. As the capabilities of these new products are confirmed, they will be made available by appropriate upgrading to the satellite or other data processing systems.

Current effort into the design of systems for sensing ice and icebergs and for processing and integrating data from aircraft and satellites can be expected to pay off in an effective and sophisticated system in the next few years.

7.2 HIGHLIGHTS OF THE REPORT OF THE LANDS DIRECTORATE, ENVIRONMENT CANADA

During the past year, Lands Directorate remote sensing interests have been focussed upon land use and land cover monitoring, and methodological development research. The Directorate also continues to be a significant customer for both satellite and airborne imagery in its northern- and urban-centred regions projects.

Ecological land research

The Directorate continued expansion of its LANDSAT transparency collection for ecological land surveys in the Baffin region. This collection now covers all of Canada and almost all image centres with exceptions only in isolated northern areas. Airborne and NOAA imagery have also been used in the past year for a primary resources survey of the proposed national park area on Ellesmere Island in co-operation with Parks Canada. Specialized digital studies using MSS LANDSAT data for vegetation and ecological surveys and 1:250,000 map production for two areas--Coats Island, N.W.T. in Hudson Bay (in co-operation with the Geological Survey of Canada) and the Great Plain of the Koukdjuak, Baffin Island, N.W.T., (in co-operation with the Nova Scotia Land Survey Institute)--are now in progress.

Airborne imagery has been acquired for special area studies including the Lake Harbour, N.W.T. Regional Planning Study and selected areas of the Great Plain of th Koukdjuak.

Land use/land cover monitoring

Airborne photography has been utilized extensively over the last several years for land use monitoring of urban expansion into rural areas surrounding the 84 urban-centred regions of Canada.

A study funded jointly by Supply and Services Canada, the Canadian Wildlife Service, and the Lands Directorate is underway to evaluate the accuracy and effectiveness for wetland monitoring of LANDSAT TM digital data in three test areas of British Columbia. This study is being conducted by Dr. G. Tomlins of B.C. Research, Vancouver. A PERCEPTRON image analysis system with EASI/PACE software, and an ADAGE 3006 display hosted on VAX 11/780 mini-computer has been acquired by B.C. Research for this project. Dr. Tomlins advises that this system will be commercially available in 1985-86 at their Vancouver offices. The Directorate has also submitted a proposal to acquire stereo SPOT imagery in Atlantic Canada for evaluation of imagery in Atlantic Canada in order to assess land-use monitoring capabilities.

A national land-cover mapping project, integrating manual LANDSAT image interpretation and the national Ecodistrict data base developed by the Lands Directorate, was initiated in July 1984, with completion scheduled for mid-1985. The final products are to be a data file for over 6000 ecodistrict map units of 12 major cover types and 1:1,000,000 file maps. Publication by the National Atlas of Canada is proposed for 1986 at a generalized scale of 1:7,500,000. The project is being undertaken in co-operation with the Geographical Research Division of Energy, Mines and Resources Canada.

Canada land data system/CLDS

The CLDS continues to be intensively utilized for the Canada Land Use Monitoring Program, planning applications in National Parks, for Northern Land Use Planning and by provincial natural resource agencies. The Directorate has implemented a new scanner system and raster-to-vector editing station as a result of an unsolicited proposal supported by the Surveys and Mapping Branch of Energy, Mines and Resources Canada, by the Land Resource Research Institute of Agriculture Canada, Parks Canada and the Canadian Forestry Service.

In co-operation with the Food and Agricultural Organization of the United Nations (Rome) a land-use planning demonstration is in progress for a 14-nation region of West Africa. This project integrates environmental, social and economic data to permit estimation of food and fuel wood production and carrying capacity of the land. Data from conventional and satellite sources including NOAA is in use.