REMOTE SENSING IN CANADA

ISSN 0226—479X

Volume 11, No. 1 **Fall, 1983**

A NATIONAL PROGRAMME IN REMOTE SENSING IS COORDINATED BY THE DEPARTMENT OF ENERGY, MINES AND RESOURCES IN CO-OPERATION WITH OTHER AGENCIES OF THE GOVERNMENT OF CANADA, PROVINCIAL GOVERNMENTS, INDUSTRY AND CANADIAN UNIVERSITIES

FOR FURTHER INFORMATION CONTACT:
THE CANADA CENTRE FOR REMOTE SENSING
DEPARTMENT OF ENERGY, MINES & RESOURCES
2464 Sheffield Road, Ottawa, Canada K1A 0Y7
Telephone (613) 993-0121

1983 Annual Meeting
Canadian Advisory Committee
on Remote Sensing

The twelfth annual meeting of the Canadian Advisory Committee on Remote Sensing (CACRS) took place at Arnprior, Ontario from May 9-12, 1983. Present at the meeting were the CACRS provincial representatives, chairmen of the various CACRS working groups, representatives of specialty groups and invited speakers from Canadian industry.

The general topic of the meeting was "New Initiatives in the National Remote Sensing Program". Presentations were made describing the various new initiatives: LANDSAT-4 (including TM); LDIAS; plans for ERS-1 and SPOT; RADARSAT; MOSAICS; the Technology Enhancement Program (TEP); and increased industrial involvement in the Canadian remote sensing program.

Industrial Panel

An industrial panel, made up of senior representatives from ten Canadian companies with interests in remote sensing, addressed the following questions:

(a) Is the sale of remote sensing satellite data a commercially viable activity in Canada, assuming the continued availability of LANDSAT-type data products?

(b) How could industry operate such a commercial activity, taking into account the research and development nature of the present Canadian government program?

(c) Are the new initiatives leading towards more industrial involvement in the Canadian remote sensing program?

A number of conclusions were reached in the discussion following the panel presentation. The continued availability of multispectral LANDSAT-type data is the highest program priority, in order to maintain existing systems using the data and in order to continue the process of weaning resource managers away from conventional sources of information. The benefit/cost ratio in remote sensing has not yet been adequately assessed, particularly on a world-wide basis. Increased industrial involvement is both necessary and desirable for the health of the overall Canadian program, but the timing of its implementation needs careful thought. No one agency or company could undertake the total system, and so the program should be broken into components that can be more easily handled.

Plenary Session

The plenary session broke into regional workshop groups to discuss issues and priorities. The Western Provinces group recommended the development of contingency plans in view of the uncertainties in the LANDSAT program, and expressed support for LDIAS, MOSAICS and TEP. The Ontario group, emphasizing the need for continuity of digital visual data, recommended continued participation in the LANDSAT program, support for the SPOT program, and recommended that an optical sensor be selected as the secondary RADARSAT sensor. The Québec group urged that francophone representation on CACRS working groups be increased, and that an applications user group be formed to advise on the LDIAS project. The Atlantic Provinces group placed highest priority on extending the TEP in the Maritime region, and reminded CCRS of the need to provide eastern users with timely access to LANDSAT and NOAA data at a uniform Canadian price and with full archiving of eastern data, now that the Shoe Cove Satellite Station has been closed.

Further details concerning the CACRS meeting, including the full text of all recommendations made, will be found in the CACRS Report to be published later in 1983.

F. MacDonnell
CACRS Liaison

Editor's Note

Volume 11, Number 1 of "Remote Sensing in Canada" introduces a new editor, Marianne Pringle, who has recently assumed the duties of Publications Coordinator at CCRS. The newsletter, to be published quarterly, attempts to keep the Canadian remote sensing community informed of key developments in remote sensing in Canada and elsewhere. It also tries to reflect the broad range of interests of this group. Such a task would be impossible, were it is not for the assistance of contributors across the country and so warm thanks are extended to all who submitted material for this issue. Contributions for future issues are invited and should be addressed to:

The Editor
Remote Sensing in Canada
Canada Centre for Remote Sensing
2464 Sheffield Road
Ottawa, Ontario K1A 0Y7

Deadline for submissions for the next issue is January 15, 1983.

INVITATION

9th Canadian Symposium
on Remote Sensing

The 9th Canadian Symposium on Remote Sensing will be held in St. John's, Newfoundland between August 13 and 17, 1984. The main theme of the meeting is "Remote Sensing for the Development and Management of Frontier Areas: the oceans, the north, forest lands and wilderness, etc." The Symposium is sponsored by the Canadian Remote Sensing Society.

The members of the organizing committee extend their welcome and ask for your participation. The first notice of call for papers will be issued shortly.

Dr. D. Bajzak, Technical Chairman
Memorial University of Newfoundland

LANDSAT-4 Status Report

The LANDSAT-4 spacecraft launched on July, 1982 has experienced technical problems that have affected its imaging and data transmission capabilities.

The first problem has been the failure, in February 1983, of the X-band radio channel required to transmit the Thematic Mapper (TM) data directly to ground stations, effectively incapacitating the system. The Multispectral Scanner (MSS) system was not affected, as it uses a separate S-band radio channel.

A second problem, noted in March 1983, is the partial loss of power to the satellite, due to a gradual failure of electrical cables in the solar panel system. As of now, available power allows near-normal MSS operations; however, NASA/NOAA has indicated that the power situation aboard the spacecraft may become critical later in the year. Should this occur the satellite will be shut down and the spacecraft placed in a lower orbit to make it retrievable by the Space Shuttle in 1986.

NASA/NOAA is seeking approval to launch a reserve satellite, LANDSAT-D prime, as soon as possible. The expected time-frame for launch is February-March, 1984.

LANDSAT-2 and LANDSAT-3 are no longer operational.

CCRS Technology Enhancement Program

Established in 1981 to help provincial and territorial governments enhance their remote sensing capabilities, the Technology Enhancement Office (TEO) enters into agreements to undertake joint studies. To date, Memoranda of Agreement have been signed with Manitoba (November, 1982) and the Council of Maritime Premiers (May, 1983).

The Technology Enhancement Program (TEP) brings together CCRS image analysis specialists, provincial remote sensing specialists and provincial resource managers. The head of the TEO is J.D. (Douglas) Heyland, assisted by Tom Alföldi. In Manitoba, CCRS image analysis specialist Larry Horn works with remote sensing specialists at the Manitoba Remote Sensing Centre (MRSC) and with provincial resource specialists. W.G. Best, Chief of the MRSC, is Manitoba Coordinator for the TEP. The image analysis specialists for the Maritime region are Mary Dwyer-Rigby, using at present the image analysis system at the Nova Scotia Land Survey Institute, Laurencetown, N.S., and Eugene Derenyi, using the image analysis facilities at the University of New Brunswick in Fredericton. Both Rigby and Derenyi will also assist with PEI projects. Carl Demings of the Maritime Resource Management Service (MRMS), Amherst, N.S., is Coordinator of the Maritime TEP under the guidance of the Maritime Remote Sensing Committee (MRSC).

In addition to providing specialized staff, CCRS has loaned a DIPIX ARIES-II image analysis system to the MRSC for the duration of the Manitoba program. Discussions are also under way, aimed at providing the Maritime Remote Sensing Committee with access to a system which might be installed by the MRMS in Amherst. In both the Manitoba and the Maritime programs, provincial governments cover the cost of all satellite and airborne data. The provincial resource agencies are urged to dedicate manpower to the analysis of their data with the assistance of image analysis specialists.

An evaluation of the TEP must be carried out by the Government of Canada over the next 6 months. When the evaluation has been completed, the possibility of a program extension may exist, subject to approval of resources.

J.D. Heyland
CCRS Technology Enhancement Program

Manitoba Remote Sensing Centre

The Manitoba Remote Sensing Centre (MRSC) is a section within the Department of Natural Resources, Surveys and Mapping Branch. The Centre provides assistance to government departments and agencies, universities, private industry and the general public in the coordination, acquisition and application of satellite and airborne data. The goal of the Centre is to bring remote sensing into operational use for monitoring environmental quality and provide information to resource managers so that optimum advantage can be achieved from Manitoba's natural resources.

Manitoba is participating in the federal government Technology Enhancement Program (TEP) to demonstrate the value of remote sensing technology for the management of the province's natural resources. The program involves federal agencies as developers and provincial agencies as adopters of remote sensing methods and techniques. This program has been made possible through a Memorandum of Understanding between the Department of Natural Resources, Manitoba and the Department of Energy, Mines and Resources, Canada. The TEP demonstration projects being carried out are:

Crop Data Monitoring

A crop data monitoring project is being conducted during the 1983 crop season in three Manitoba crop districts as a cooperative venture of MRSC, the Manitoba Department of Agriculture, CCRS and Statistics Canada. The project will demonstrate the feasibility of using remote sensing techniques for crop reporting in Manitoba by providing estimates of crop acreage for canola, spring grains and summerfallow, using a technique developed by CCRS and Statistics Canada to generate estimates in other regions of Canada.

Forest Fuel and Wildfire Mapping

The primary objective of this study is to demonstrate the utility of LANDSAT MSS digital data for forest fuel-type mapping. In addition, the 1983 wildfires within the study area are being mapped and the costs and accuracy of digital techniques will be compared with analog methods.

Moose Habitat Monitoring

In north central Manitoba a land area of approximately 151,000 km^2 has been affected by the alteration of water regimes through the Lake Winnipeg regulation and Churchill River diversion hydroelectric projects. The landscape and the related renewable natural resources have been markedly changed. There is an apparent shortage of moose to meet local needs and current moose management information does not permit an accurate estimate of existing moose populations. Habitat maps would provide the data required to prepare cost-effective aerial moose census flights; the objective of this project is to demonstrate the use of LANDSAT MSS digital data in mapping and quantifying moose habitat.

Assessment of Land Use Changes

The changing land use/land cover in the Valley River watershed was studied in order to assess natural and anthropogenic changes. Conventional air photos and satellite imagery documented land use/land cover changes within the 1,786 square kilometre watershed. Objectives of the study are:

1) to provide thematic maps and tabular data of land use/land cover for the Valley River watershed for 1948, 1969 and 1981

2) to demonstrate the use of remote sensing techniques for fisheries resource management

3) to identify ecological implications of agricultural developments within a watershed

4) to examine and compare cost, time and accuracy factors of land use/land cover mapping using LANDSAT digital data and conventional data.

Park Site Land Use Mapping

Land cover mapping is needed on the east side of Lake Winnipeg in order to assess the region's suitability for future park development. This project will demonstrate the feasibility of using remote sensing technology to meet the information needs of park planners by using LANDSAT digital MSS data for land cover mapping and providing photographic reproductions and thematic maps of the results. Aerial photographs and forest inventory maps will be used for ground truth and accuracy assessments.

Flood Mapping

This project will record the extent of flooding in Manitoba. The data sources to be used are digital satellite imagery and colour infrared aerial photographs: maps compiled from each of the data sources will be compared. The

(Cont. p. 4)

(from p. 3)

final product, a 1:50,000 flooded area map, is required within two months of the flood occurrence.

Other MRSC Projects

Mapping Rangeland in Agro-Manitoba

A study is underway on the northern fringe of Agro-Manitoba to demonstrate the feasibility of using LANDSAT and remote sensing techniques for rangeland mapping. The project will provide reliable information on land use and land development between the years 1975 and 1981, and an estimate of land available for forage production during dry and wet conditions will be made. Study methods will integrate ground reference data, air photo interpretation and computer-aided image analysis techniques.

Monitoring Irrigation Activity

This project, a cooperative venture of the MRSC, the Manitoba Water Resources Branch and CCRS will be conducted during the fall of 1983 and will demonstrate the application of remote sensing techniques for ground water resource management. Specifically, land use and land use changes will be mapped for the Assiniboine Delta Aquifer. This information will serve as one input into the calculation of the overall water budget for the aquifer. Knowledge of the aquifer's water budget will enable modelling and monitoring of the effects of sustained irrigation activities on the non-irrigated and surrounding natural areas.

For further information regarding any of those projects, contact the MRSC, 1007 Century Street, Winnipeg, Manitoba, R3H 0W4, (204) 633-9543, Ext. 229.

W.G. Best
Manitoba Remote Sensing Centre

Information in this article originally appeared in "Remote Sensing in Manitoba."

Maritime Newsletter Launched

With the Fall edition of the Maritime Remote Sensing Newsletter, the Maritime Remote Sensing Committee (MRSC) begins a quarterly communication for readers with an interest in remote sensing, including those wishing to follow the activities of the Committee in the region.

For information contact MRSC, Box 310, Amherst, N.S., B4H 3Z5, (902) 667-7231.

CCRS Falcon Fan-Jet Update

The advanced pushbroom scanner MEIS II was installed in the CCRS Falcon Fan-Jet in May 1983, after successfully completing a series of flight tests during the winter months.

MEIS II (multi-spectral electro-optical imaging scanner) was developed by CCRS as an operational second generation pushbroom scanner, and was fabricated under contract to CCRS by MacDonald, Dettwiler and Associates Ltd., of Vancouver. The sensor is designed with eight independent imaging channels and uses charge-coupled device linear array detectors, each containing 1728 elements. At the moment, five channels are used to cover the spectral range from 350 nm to 1100 nm, with each channel consisting of a selectable spectral filter, objective lens and linear array. The three unused channels provide the option of extending the spectral range further into the infrared once suitable arrays become available. MEIS II includes a real-time data processor that provides image data resampling, geometric and radiometric corrections and inter-channel registration to within a fraction of a pixel.

The imagery provided by MEIS II is characterized by good geometric fidelity and low noise, and the radiometric sensitivity is, as expected, at least two orders of magnitude greater than that of the mechanical line scanner currently in operation. Its flexibility of operation, in terms of spectral band selection, and its real-time data processing options make it a versatile sensor of interest for a range of remote sensing applications. More than twenty spectral filters have been tested with MEIS II including ones of narrow spectral width (less than 5 nm). Two sets of filters have been used primarily during its Falcon operation, one set that simulates the LANDSAT-4 satellite thematic mapper (TM) visible channels, and one set chosen for passive bathymetry work.

The sensor package installed in the Falcon includes MEIS II, the Daedalus 1260 multi-spectral scanner, an RC-10 aerial survey camera, an inertial navigation system, a high density digital tape recorder and an auxiliary data acquisition system (MAID). This sensor package has been providing the Canadian remote sensing community with operational airborne data for a range of applications.

Airborne projects flown with MEIS II installed in the Falcon during the first two months of summer 1983 include:

1. Water depth mapping (multi-temporal), Bruce Peninsula.

2. Cartography and surveying, Strathroy, Ontario.
3. Forest management (monitoring spruce budworm damage, forest site preparation and partial cuts), and studying off-nadir viewing angles in New Brunswick.
4-10. LANDSAT-4 TM simulated data acquisition (to assess automatic digital classification and enhancement of geologic mapping techniques), sites throughout Nova Scotia.
11. Water depth measurements, Magdalen Islands.
12. Multi-spectral data acquisition, to assess crop type and condition, in conjunction with SAR data acquisition (multi-temporal), Melfort, Outlook, Swift Current, Saskatchewan.
13. Wetland vegetation discrimination, Simcoe County, Ontario.
14. LANDSAT-4 simulation for detection of knapweed on interior rangeland, Pritchard, B.C.
15. Quantitative measurement of sulphur dioxide effects on vegetation, Swan Lake, Alberta.
16. LANDSAT-4 simulated data acquisition of anticipated gold producing area, Marathon, Ontario.
17. Evaluation of digital sensors for cartography, Ottawa.
18. LANDSAT-4 TM simulation for agricultural and cartographic applications (multi-temporal), Sorel, Quebec.
19. Potato area estimation, Prince Edward Island.
20. LANDSAT-4 simulated data acquisition for soil survey maps, S.W. Ontario.
21. LANDSAT-4 simulated data acquisition for agricultural applications, Sherbrooke, Quebec.

S.M. Till
CCRS Data Acquisition Division

SAR-580

Early in 1983, the SAR was restructured to accomodate a new azimuth and elevation platform for the antenna, a new azimuth drive, waveguide runs and rotary joints for X- and C-band. These modifications improved the capability of the SAR and contributed to a very productive and successful season.

SAR-580 began the season on April 10 in the Hibernia area off the coast of Newfoundland exploring the SAR's ability to detect icebergs in open ocean. The project was carried out in cooperation with Mobil Oil and RADARSAT. Because of the record number of icebergs off the east coast of Canada this year, the iceberg project was repeated between June 4 and 6.

The successful Alaska lease project of last year was repeated between April 23 and 30. More high quality SAR multi-year ice mosaics were collected. En route to St. John's for the iceberg project on June 3, the SAR-580 carried out a RADARSAT project to evaluate the SAR in the delineation and analysis of geological surfaces in Chedabucto Bay, N.S.

To evaluate the use of SAR X-, C- and L-band data for monitoring agricultural crops and for determining soil condition and moisture, RADARSAT scheduled several SAR missions in the Melfort area of Saskatchewan. The missions took place June 9-14, June 24-27, July 19-21, July 28-31, and August 12-16. Also in June, SAR-580 conducted a bistatic radar experiment with the Environmental Institute of Michigan (ERIM).

In a cooperative project with ERIM, SAR-580 was based in Norway from June 28 to July 15. Both synoptic and high resolution SAR imagery of the marginal ice zone was collected in the Fram Strait/Greenland Sea area.

Between July 22 and 28, SAR-580 was based at Victoria B.C. and Everet, Washington for the first part of the Georgia Strait experiment. The project was an international, multi-agency, multi-platform, multi-sensor measurement program funded by the Department of National Defence (Canada). Its primary purpose was to characterize radar scattering processes responsible for the observed SAR signatures of ocean internal wave fields and ship wakes in terms of sea surface variables and environmental conditions.

SAR-580 arrived at Comox, B.C. on August 1, in time for the B.C. Day air show. For the next six days imagery was collected for the second part of the Georgia Strait experiment.

Two major deployments are planned in the next six months: in October SAR-580 will travel to Japan to collect SAR imagery, and in February to Europe for the ESA wind scatterometer experiment. It is expected that the aircraft will also be used in a number of smaller domestic projects.

Man Wong
CCRS Data Acquisition Division

MEIS II To See Double Too

Digital processing techniques are already being incorporated into the extraction of elevations from stereo aerial photography. The non-digital link in the chain at the present time is the photographic camera, the images from which must be analyzed with a stereo photo plotter or an analytical plotter. The photographic imagery can also be converted to measure the parallax and hence the topographic relief. If the photographic camera could be replaced with an electro-optical imager, it should be possible to develop a mapping and elevation modelling system that is digital from end-to-end. Because the data would be produced in a computer compatible form, the subsequent processing to produce digital elevation models would be both more automated and more flexible. In addition, the increase in dynamic range and radiometric sensitivity would facilitate feature identification and improve accuracy in the automated correlation procedure. The geometric fidelity of the 'pushbroom' electro-optical imager is also inherently better than with the photographic camera since the photo-sensitive components, the CCD arrays, retain a fixed geometry whereas film is subject to distortions.

CCRS has embarked on an experiment to acquire single pass stereo MEIS imagery this fall. This involves attaching fixed mirrors to the front of MEIS, deflecting the viewing angle of one of the MEIS channels forward by 30°, and of another channel aft by 30°. MEIS will thereby produce two views of the same scene separated in view direction by 60° and separated in time by a relatively short interval dependent upon altitude, e.g., 27 seconds at 3000 m altitude. Nadir imagery in three different spectral bands will also be available. Geometric corrections will be applied post-flight, utilizing high resolution INS data recorded on MAID to compensate for aircraft attitude variations.

MEIS II, with only 1024 pixels per image line, cannot achieve satisfactory resolution for a given swath width; however, it will be an excellent vehicle for testing this technique. The detector array technology exists, developed by Bell Northern Research/Northern Telecom, to produce a 'pushbroom' electro-optical imager with the same resolution as is presently available with an aerial mapping camera.

In summary, a digital mapping system based on an electro-optical line imager offers many potential advantages over current methods. The technology is available to begin the task of developing a demonstration system.

R. Neville
CCRS Data Acquisition Division

The Convair Adds a New Wing this Fall

Because of the interest in C-band generated by this choice of radar frequency for both the ESA ERS-1 and Canadian RADARSAT satellites, CCRS is soon to acquire a new C-Band scatterometer. The new system, which is being developed by MPB Technologies of Montreal, is designed to measure radar backscatter and will have its four antennas mounted in a special 2.5 m wide 'wing' which will be positioned below the fuselage just in front of the main wings of the Convair.

This will be an important addition to the Convair's microwave sensor payload, complementing the existing Ku-Band scatterometer and the X/L/C synthetic aperture radar. The two scatterometers will be able to work simultaneously and will provide radar backscatter as a function of polarization and incidence angle, an especially important function in designing and planning for a satellite radar. Applications for the new system include measurement and study of sea-ice backscatter, ocean backscatter as a function of wind speed and direction, and radar crop classification.

As well as the new scatterometer hardware, a new digitizer has been designed and built by the Data Acquisition Division of CCRS. The digitizer will ultimately handle data from both scatterometers and will add and interleave the navigation and aircraft attitude data necessary for accurate post-flight processing. Testing of the new system will begin this fall and it is planned that the Convair with its new 'wing' will participate in an ESA ocean backscatter measurement program early in 1984.

L. Gray
R. Hawkins
CCRS Data Acquisition Division

The Kananaskis Caper

In a conventional aerial photogrammetric survey from an altitude of 7600 m (or a mapping scale of 1:50,000), monuments or targets are placed every 20 km along the perimeter of the block to be surveyed. These targets establish the horizontal control for the block. Supplementary targets for vertical control are laid out on a 10 km grid inside the survey area. The purpose of the interior vertical control is to determine the scale of each photogrammetric model. Much of the time and expense associated with a modern aerial survey arises from the ground work required to measure and mark each of the control points.

The requirements for interior vertical control points can be reduced or eliminated if the scale of the photogrammetric models can be determined by some other means. The most obvious method is a direct measurement of the aircraft altitude above the terrain. However, barometric altimeters do not measure the distance from the camera to the ground; radar altimeters, with very broad footprints, are unsuitable. A profiling lidar altimeter is believed to be the most appropriate sensor and one has been installed on the CCRS Falcon along with the photo-inertial mapping package to demonstrate the concept. Photo-inertial mapping is a powerful technique which also reduces the amount of ground control required to achieve a specified survey accuracy. The combined system should prove extremely valuable in areas where it is difficult to establish interior ground control or where the terrain is relatively featureless such as certain forest areas, icecaps and deserts.

The CCRS profiling lidar altimeter transceiver was designed by Optech of Toronto. It consists of a frequency doubled Nd:YAG laser transmitter (which is shared with the lidar bathymeter) and a receiver telescope with detector. The lidar operates with a pulse repetition frequency of 20 Hz, thus a slant range is measured every 9 m along the aircraft track. Because the lidar has a footprint of 2 mr, the footprints overlap at altitudes above 4500 m. The nominal resolution of the lidar system is 0.3 m in slant range. The slant range is recorded on MAID along with position and attitude from the two inertial navigation systems. After the flight, the photo-inertial mapping software, resident on the CCRS Time Sharing System, extracts the camera stations and vertical profiles which are then used in subsequent steps of stereo photo plotting and block adjustment.

In the past, it has been extremely difficult to boresight an altimeter of any sort with the camera. In this lidar, the laser provides two wavelengths: NIR (1064 nm) and green (532 nm). The NIR beam is used for the altimetry and the visible green beam allows the precise position of the lidar spot to registered on the film.

The entire system was flown in August 1983 over the photogrammetric test range in the Kananaskis Valley near Calgary, Alberta where the rugged mountainous terrain is ideal for a demonstration of the advantages of lidar-photo-inertial mapping. The project is a joint effort of CCRS, the Surveys and Mapping Branch of the Dept. of Energy, Mines and Resources, the Mapping and Charting Establishment (Dept. of National Defense), and the Division of Survey Engineering (University of Calgary). The latter group is funded by the Ministry of Natural Resources (Government of Alberta).

Note: The lidar-photo-inertial package is only experimental and is not available as a production sensor on CCRS aircraft.

R. O'Neil
CCRS Data Acquisition Division

Cleaning up with MAID

Two new small Data Acquisition Systems (MAID's), designed and manufactured by MDA in Vancouver, have been installed and commissioned in two CCRS aircraft, the Falcon (C-GRSD), and in the Convair 580 (C-GRSC). MAID has been designed principally to record aircraft data required for track recovery and geometric correction of imagery. In addition, the system identifies sensor malfunctions and may be interfaced to other common data sources. MAID is very simple to operate and does not require a dedicated sensor operator.

MAID consists of three major components: the Data Acquisition and Recording Unit, the Camera Annotation Controller and the Inertial Navigation Monitor and Program Loader (INM). The INM is used for acquiring precision navigation parameters from the Inertial Navigation System LTN-51 for transmission to the Data Acquisition and Recording Unit. Aircraft position, velocity and attitude from the inertial system, the radar altitude and the barometric altitude are recorded together with the time on computer compatible tape (CCT) in the Johnson Space Centre Non-Imagery Format. The Camera Annotation Controller is, in fact, an independent system which annotates the RC-10's and Hasselblad cameras with data, time, position, heading and aircraft number.

J. Granot
CCRS Data Acquisition Division

LARSEN-500

The CCRS MkII lidar bathymeter (a profile measurement system), was flown in several demonstration projects: Magdalen Islands (Gulf of St. Lawrence 1979), Gananoque (St. Lawrence River 1979), Bruce Peninsula (Lake Huron 1982). In each case a small amount of data was collected and reduced. With these data sets, the Canadian Hydrographic Service (CHS) has determined that a lidar bathymeter, with the addition of a scanning capabililty, will meet its requirements for coastal charting in Canada.

The acquisition of the most recent of these data sets was complemented by a study of the propagation of the lidar pulse through the water column. The intent of the study, carried out by Moniteq, was to predict the magnitude of depth residual (the difference in the depth measured by the lidar bathymeter and a conventional acoustic sounder) under a variety of environmental conditions. Moniteq has developed a depth correction algorithm which has been incorporated into the BEST software package used to manipulate the lidar data and determine the depth. The study also led to numerous recommendations which have influenced the design of the scanning lidar system.

Canadian Remote Sensing Society (CRSS) 1983-1984 Executive

At the CRSS Annual General Meeting held in Montreal on May 4, 1983 the following officers were named. Chairman: Simsek Pala, Ontario Centre for Remote Sensing; Vice-Chairman: Ferdinand Bonn, Université de Sherbrooke; Secretary-Treasurer: Brian McGurrin, Canada Centre for Remote Sensing (CCRS); Regional Councillors: Jeff Tomlins, B.C. Research, British Columbia; Ken Campbell, Alberta Remote Sensing Center, Alberta/Saskatchewan; Roy Dixon, Manitoba Remote Sensing Centre, Manitoba; Eugene Derenyi, University of New Brunswick, Maritimes; Denes Bajzak, Memorial University, Newfoundland. Councillors for Ontario and Quebec are to be named.

CRSS is a Constituent Society of the Canadian Aeronautics and Space Institute (CASI). CRSS sponsors the Canadian Symposium on Remote Sensing and publishes the Canadian Journal of Remote Sensing.

Canadian Remote Sensing Society
Saxe Building, Suite 75
60 Sparks Street
Ottawa, Ontario
K1P 5A5
(613) 234-0191

The MkIII scanning lidar bathymeter system consists of four major systems: the lidar transceiver, a navigation and guidance system, a data acquisition system (BERS II) and a portable ground processing facility (LEPS).

The lidar transceiver will be an evolution of the MkII transceiver in that many of the same components, including the laser and detector, will be used. The theoretical studies have shown that the depth residual is least sensitive to environmental parameters at an angle of incidence of 15 degrees. The data reduction is greatly simplified if the system performance and the depth corrections which must be applied is constant for each laser shot. Thus a conical scanner is being implemented. Sounding shall be made from an altitude of 500 m yielding a swath width of 270 m. At a laser pulse repetition rate of 20 Hz it is possible to acquire soundings on a 30 m grid.

The navigation system consists of a microwave range positioning system, a strapdown inertial system to measure attitude and an independent nadir looking lidar altimeter. The data from these three components will be combined to provide real time flight line guidance (cross track error, cross track velocity, altitude) to the pilot. The best estimate of the current aircraft position will be recorded on the data acquisition system together with the raw ranges, attitude, and altitude. From this it hall be possible to determine the position of each sounding to an accuracy of 25 m (circular error probability).

The data acquisition system, called BERS (for Bottom Echo Recording System), accepts data from the position and guidance system, the actual lidar return waveforms and other miscellaneous control and status information required in the data reduction. This data is written to a computer compatible tape (CCT). BERS also displays the incoming raw data on a video monitor and annotates the low light level television camera which provides a visual record of the ground track.

BERS tapes are read by LEPS (Lidar Echo Processing System) and converted to disk files. Using the BEST software package, the depths are extracted from the lidar data and the corrections applied. At the same time LEPS reprocesses the navigation data to provide an accurate position for each sounding. Finally the position and depth are plotted as a field sheet. LEPS will reside in a cargo container on a semi-trailer. The trailer, which has its own generator, heat and air conditioning, is a completely self-contained facility for the reduction of lidar data in the field. This is a somewhat unusual approach in remote sensing but it is essential that the Hydrographer-in-Charge review the survey progress on a daily basis. The throughput of LEPS is thus determined: it must process all the data from a day's flying and plot the updated field sheet in less than 12 hours. The final product of a lidar survey is the lidar field sheet which is then integrated with the acoustic soundings, archived data, aids to navigation, shoreline and social detail to create the final hydrographic chart.

The scanning lidar system will be named LARSEN-500. In the tradition of the Canadian Hydrographic Service, major systems, ships and institutions are named after persons who have made a contribution to the charting of Canadian waters. Sgt. H.A. Larsen was the captain of the RCMP schooner "St. Roche", the first ship to traverse the Northwest passage from the east and from the west. The name is particularly appropriate in that the Arctic Islands are expected to be the principal area in Canada suitable for lidar surveys. The 500 refers to the operational altitude of the system.

LARSEN-500 is being designed and built by Optech of Toronto. The development of system hardware is being funded by the Department of Supply and Services and CHS. CHS, through a major five-year development project, has assured the evolution of LARSEN-500 to a well-proven operational system. CCRS will continue to provide technical advice and access to its aircraft. Commissioning of the system will begin in the fall of 1984 and the first pilot projects with the system will take place in southern Canada in the spring of 1985. Initially LARSEN-500 will be mounted in a CCRS DC-3 but eventually it is expected that it will fly in a Twin Otter or a medium sized helicoper such as a B-212.

R. O'Neil
CCRS Data Acquisition Division

The Blossoming of IRIS

A new synthetic aperture radar (SAR) is being developed for CCRS by MDA and Canadian Astronautics Limited, to replace the X, C, L-band instrument now flown in the CCRS CV-580.

IRIS is the second of a new generation of SAR's designed specifically for civilian remote sensing applications. The first is STAR 1, developed for Intera Environmental Consultants Ltd. by ERIM and MDA. In IRIS, current generation digital technology is combined with new motion sensing and navigation technology, to produce the most advanced remote sensing SAR now in existence. The radar will feature full digital control, range distributed motion compensation, synchronous like- and cross-polarized channels, single channel real time ground range corrected imagery, single channel processed video recording, and dual channel digital recording of unprocessed SAR data.

IRIS has been developed principally to support RADARSAT applications development and thus will initially operate only in the C-band (5.31 GHz). X-band channels will be added at a later date as funding becomes available.

By the spring of 1985, IRIS will be installed in the Convair-580 and the commissioning of the sensor will be sufficiently advanced that users should consider data acquisition missions.

C.E. Livingstone
CCRS Data Acquisition Division

IRIS Design Specifications

MODE	PRESENTATION	SWATH WIDTH	RANGE RESOLUTION	AZIMUTH RESOLUTION	NUMBER LOOKS
Nadir	Slant range	18 km	4.8 m	6 m	7
High Resolution	Ground range	18 km	4.8 m	6 m	7
Wide Swath	Ground range	63 km	19 m	10 m	7

Coastal Zone Colour Scanner (CZCS) New Spectral Data for Water

The CZCS has been mapping ocean colour from the Nimbus 7 satellite since 1978 and fully processed data are now being routinely produced by NASA. The scanner gives pictures on roughly the same scale as the AVHRR - 800 m nadir resolution, scanning out to about 40 degrees on each side of the satellite - and has produced some beautiful images of the colour patterns associated with plankton growth in and near the Gulf Stream, on the continental shelves and in mid-ocean.

The sensor has four high sensitivity bands, each 20 nm wide, at 443 nm (blue), 520 nm (blue-green), 550 nm (green) and 670 nm (red), a low sensitivity near infrared band, 700 to 800 nm, and a thermal channel at 12 microns that has operated only intermittently. The near infrared band has been used as a water detector for subsequent processing of the other bands. The visible bands each give different views of water patterns and can be combined to make quantitative estimates of phytoplankton concentration and inorganic suspended matter such as river silt. The bands have higher sensitivity than LANDSAT and therefore show the faint colour differences that exist in different parts of the ocean, especially near the coasts where more nutrients are available for plankton growth.

The 520 and 550 nm bands show patterns similar to those in the LANDSAT green band, due to suspended material, silt or growing plankton. The 443 nm blue band shows, for the first time from space, the characteristic darkening of water containing the chlorophyll pigments present in photosynthesizing plankton. The 670 nm band is less affected than the LANDSAT red band by water colour changes and can be used to measure aerosols (thin cloud or haze) and hence to correct the other bands.

The scanner can tilt its field of view up to 20 degrees fore or aft to avoid the sunglint contamination often found in satellite visible data, especially in data from wide field of view instruments. NASA's Level 1 data "CRTT" tapes provide geographic references by giving latitude and longitude at 77 points along each scan line. In the Level 2 data the measured radiances are also corrected for atmospheric effects, and chlorophyll pigment concentrations are computed. The processed results show that the wide area scans, giving coverage on three out of seven days, map water colour patterns in cloud-free areas at a scale useful for studies of the basic food distribution available to fisheries, and for studies of water movement on the continental shelves and further offshore. Studies using the data are now under way on the east and west coasts of Canada and in the Great Lakes.

Data at either Level 1 or Level 2 is available from the USA at:

National Oceanic and Atmospheric Administration, Environmental Data and Information Service (NOAA/EDIS)
Satellite Data Service Division
World Weather Building, Room 110
Washington, D.C. 20233

First enquiries should be for a listing of the dates, times and orbit numbers of passes over the target area in the time frame required, with an indication of extent of cloud cover. Quick-look (Level 1) prints or transparencies can then be ordered, followed by Level 1 or Level 2 tapes or Level 2 imagery as appropriate. Each scene (if complete) represents two minutes of data and covers about 750 x 2000 km.

J.F. Gower, Institute of Ocean Sciences
Department of Fisheries and Oceans
Sidney, British Columbia

Fluorescence Line Imager Program

J.F. Gower of the Institute of Ocean Sciences is leading a Canadian team in developing a programmable spectroscopic imager capable of measuring chlorophyll _a_ concentrations from a space satellite system. Forming an image of chlorophyll fluorescence has not previously been attempted. The Canadian instrument will use solid state imaging technology to measure the natural fluorescence signal at 685 nm from phytoplankton and improve the sensitivity of the traditional green/blue ratioing method. The light at the blue end of the optical spectrum is more affected by scattering in the atmosphere, and the green/blue ratio does not discriminate between suspended solids and chlorophyll _a_ in the near shore regions. Mapping the two properties of the plankton simultaneously should lead to increased accuracy in the results and may allow study of the changing properties of phytoplankton as it grows and decays.

The Phase I development of a prototype sensor for aircraft experimental surveys and evaluation has been contracted to Moniteq Limited of Toronto, Ontario. Initially, the instrument will be flown on CCRS aircraft and will be available for optical imaging experiments over oceans and land targets. Participation in the sensor and data evaluation phase are welcomed.

H.R. Edel, Remote Sensing Coordinator
Department of Fisheries and Oceans

Numerical Image Analysis System at University of Sherbrooke

On March 11, 1983, the Department of Geography, University of Sherbrooke inaugurated the numerical image analysis system at its remote sensing laboratory. This system consists of the following units:

- a colour video station and a DIPIX ARIES-II video processor
- an IMAPRO photographic printer
- the basic software provided with the ARIES-II system.

The system was financed by the Natural Sciences and Engineering Research Council (NSERC) (70%) and the Formation de chercheurs et d'action concertée (FCAC) program of the Quebec Department of Education (30%).

The system will be used for educational and research purposes. The remote sensing laboratory of the University of Sherbrooke has about twenty graduate students and research is oriented toward the potential applications of future satellites (RADARSAT, SPOT and LANDSAT-TM). Application themes range from geomorphology to marine biology, and include agriculture and land use in urban environments. The main sensors studied are radar and heat sensors.

M. Bernier
CCRS Applications Technology Division

Processing Colour Infrared Film as a Negative

The Ontario Centre for Remote Sensing (OCRS) recently compared four film types to determine which was best for haze penetration. The project aimed to increase the number of days per year suitable for forest inventory aerial photography. False-colour infrared film (Kodak Aerochrome Infrared 2443) proved to be much less subject to the fogging effect caused by green, red and infrared light scattered by haze, than were normal colour, or black and white panchromatic, or infrared films. When used with a yellow filter to block out diffused blue light, colour infrared film is virtually unaffected by haze.

Although interpreters have long recognized the excellence of colour infrared film for vegetation discrimination, they have hesitated to use it because of its narrow exposure latitude and the inconsistency of its colour quality. In a search for better quality control over the final product, OCRS experimented with the processing of colour infrared film as a negative, using the Kodak C-22 process. Colour printing from a negative provides greater scope for correcting slight errors in exposure and colour, through filtration, than exists in the reversal printing process: this technique effectively broadens the exposure latitude of colour infrared film. OCRS interpreters compared colour prints made from negative film with reversal prints made from positive colour infrared film of the same flight line, and concluded that the prints from the negative film were superior in colour range and saturation, and in fineness of grain.

Tests were subsequently conducted on the production of black and white prints from the colour infrared negative film, using subtractive filters to enhance selected ranges of the spectrum. This technique offers the infrared information content in an inexpensive black and white format, while also providing a source of colour prints.

The preliminary conclusion drawn from this research is that the negative processing and printing technique has the potential to overcome many of the barriers standing in the way of extensive use of colour infrared film, particularly in forest inventory. Later this year, a formal interpretation test will be conducted jointly by OCRS and the Ontario Forest Resources Inventory to compare the quality of prints made from colour infrared negative film with that of standard panchromatic prints, for use in operational forest inventory photo interpretation.

For further information, contact Victor Zsilinszky (Director) or Dusan Klimes (Photo Research Supervisor), Ontario Centre for Remote Sensing, 880 Bay Street, 3rd Floor, Toronto, Ontario, M5S 1Z8.

Newfoundland Joins the Maritime Remote Sensing Committee

After sitting in on meetings of the Maritime Remote Sensing Committee as an observer for over a year, Newfoundland has now become its newest member. Acting on a request from Premier A. Brian Peckford, the Council of Maritime Premiers, meeting in session on July 25, 1983, accepted Newfoundland as a full member of the MRSC.

C.O. Demings, Coordinator
Maritime Remote Sensing Committee

TEP in the Maritimes

In May, 1983 the Council of Maritime Premiers and the Department of Energy, Mines and Resources signed a Memorandum of Understanding stating their intention to "Pursue scientific and technical cooperation in remote sensing".

The Memorandum established the framework for enhancing the scientific and technical capabilities of the Maritime provinces in the application of remote sensing technology to natural resource management activities. It remains in force until March 31, 1984 when it may be extended by mutual agreement of the parties.

A joint Maritime Region Technology Enhancement Program undertakes projects designed to demonstrate digital analysis techniques in a number of disciplines. These include:

1. Forest clearcuts and logging road monitoring, Nova Scotia Department of Lands and Forests.
2. Forest clearcut monitoring, New Brunswick Department of Natural Resources.
3. Forest depletion monitoring, P.E.I. Department of Energy and Forestry.
4. Soil erosion and field crop monitoring, New Brunswick Department of Agriculture and Rural Development.
5. Field crop monitoring, soil erosion assessment, P.E.I. Department of Agriculture.
6. Near real-time snow cover monitoring and mapping, New Brunswick Department of the Environment.
7. Inventory and monitoring of peatlands, Nova Scotia Department of Mines and Energy.
8. Geologic mapping of selected sites in Nova Scotia, Nova Scotia Department of Mines and Energy.

C.O. Demings, Coordinator
Maritime Remote Sensing Committee

12th Alberta Remote Sensing Course

University of Alberta,
Edmonton, Alberta
20-24 February, 1984

This course is conducted by the Alberta Remote Sensing Center in cooperation with the Faculty of Extension, University of Alberta. Its purpose is to develop practical expertise in using remote sensing in earth surveys and management.

The course is designed to instruct multidisciplinary users in the application, acquisition and interpretation of earth resources satellite (LANDSAT) and aircraft multiband data (photographic and non-photographic). It will use imagery interpretation exercises based on actual research projects under the guidance of the researchers involved.

Excellent instruction will be provided by Canadian scientists from many agencies across Canada actively engaged in remote sensing and Professor R.N. (Bob) Colwell of the University of California, one of the world's leading scientists in the field of remote sensing.

The course content will include: an introduction to remote sensing; historical development; basic matter and energy relationships; data acquisition - photographic and non-photographic sensors; the Canadian satellite and airborne remote sensing programs; techniques of manual and instrument-aided image interpretation; use of digital satellite data; land use studies and classification; agricultural applications; goesciences and many more subjects. Alterations may be made to the course content as new techniques applicable to Canada's natural resources develop.

The registration fee of $200.00 includes syllabus and course materials. Registration is open to all in order of receipt. Enrollment is limited to provide better instruction. Past courses have been oversubscribed so persons should plan early to attend. Those interested in attending the course should call the Alberta Remote Sensing Center at (403) 427-2381.

DIGIM Signs Agreement with NRC

A contribution agreement was signed between the National Research Council of Canada (NRC) and DIGIM (1983) Inc. of Montreal on June 10, 1983. The agreement is for one year, from June 30, 1983 to June 30, 1984. The overall NRC contribution for the two fiscal years 1983-1984 and 1984-1985 will be $123,610.

The contribution was awarded under the NRC's Program for Industry/Laboratory Projects (PILP), set up to transfer the technology developed in federal laboratories, such as the Canada Centre for Remote Sensing, to private industry.

The DIGIM (1983) Inc. project will:

- Carry out technology transfer between remote sensing research agencies, principally the Canada Centre for Remote Sensing, and the users of these technologies - agencies of natural resources development and management.

- Develop within Canadian private enterprise the capability of offering services in the processing and numerical analysis of remote sensing data.

- Rapidly develop and offer a capability to reconstruct, in photographic form, numerical false-colour images for their subsequent interpretation by specialists in natural resource mapping.

- Establish a market for such products, by initially reducing their cost to a level below production cost or by preparing demonstration products for a broad range of potential users.

The Canada Centre for Remote Sensing and the Laurentian Forest Research Centre are supporting this project by offering their expertise as consultants.

M. Bernier
CCRS Applications Technology Division

Thai Forestry Officials Visit CCRS

In July, five officials of the Royal Thailand Forestry Department visited CCRS as part of a ten-day study tour of Canadian and American remote sensing facilities. The tour, which was sponsored by the Food and Agricultural Organization (FAO) of the United Nations and also included visits to Italy and France, familiarized the Thai officials with current remote sensing applications in forestry.

Taking part in the tour were Dr. Chumni Boonyobhas and Mr. Boonchana Klankamson, Director and Remote Sensing Chief, respectively, of the Royal Thailand Forestry Department, as well as Remote Sensing Specialist Mr. Peerasukdi Adisornprasert and Foresters Mr. Thongchai Charaffat and Mr. Prasopchai Nambabudha. CCRS organizer of the visit was Bill Bruce of the Applications Technology Division.

In addition to CCRS, the Canadian part of the tour included visits to the Canadian International Development Agency (CIDA), the Canadian Forestry Service at Petawawa, Ontario, Dipix Systems Limited, the National Research Council and the Ontario Centre for Remote Sensing.

Thailand's Forestry Department has a long history of involvement in remote sensing. A national forest depletion survey using LANDSAT data is conducted each year and departmental scientists are engaged in a variety of pilot studies ranging from tropical forest tree mapping to mangrove monitoring. In 1981, Mr. Adisornprasert spent eight months at CCRS studying Digital Image Analysis with Bill Bruce. This earlier training program was related to Thailand's decision to purchase its LANDSAT ground receiving station from a Canadian supplier, MacDonald, Dettwiler and Associates (MDA) of Vancouver.

In addition, Mr. Suvit Vibulsresth, Director of the Remote Sensing Division of Thailand's National Research Council recently visited CCRS and CIDA, and three Thai geologists have completed a four-month training program at CCRS. All these cooperative program were sponsored by CIDA.

B. Bruce
CCRS Applications Technology Division

Atlantic Remote Sensing Society Proposed

It has been proposed by the Nova Scotia Remote Sensing Committee that a remote sensing society be organized for the Atlantic area. Such a society would help organize workshops, present guest speakers and would assist in the promotion of remote sensing in the area. All those interested in joining such a society or in helping in its organization are asked to contact Mr. Herbert Ripley c/o Atlantic Canada Airborne Sensing, P.O. Box 434, Amherst, N.S. B4H 3Z5, (902) 667-1403.

East Coast LANDSAT Data

Good quality LANDSAT MSS data of the east coast are being recorded daily by the United States. A substantial archive of LANDSAT- 4 spring and summer imagery has been accumulated for 1983. CCRS maintains a list of available imagery and can obtain quality and cloud cover information by phone from the EROS Data Centre.

To date, only three requests from users have involved east coast data recorded by the U.S. In all cases total turnaround time was well within published Canadian product delivery times.

These products were one B/W print and two CCTs. The print arrived at CCRS seven calendar days after it was ordered. One of the CCTs was ordered two weeks after the date of overpass and took 9 calendar days. The other CCT, a standing order with cloud cover restrictions, took a total of 19 calendar days including 9 days between satellite overpass and availability of cloud cover information at the EROS Data Centre.

The Ottawa order desks will handle any requests for these U.S. recorded east coast data, as they do for data recorded in Canada. Also, any questions regarding availability or turnaround associated with these data can be directed to Ian Press, LANDSAT Production Coordinator, CCRS Ottawa (613) 993-0121.

LANDSAT-4 Products

MSS

MSS data for all of Canada may be ordered from CCRS. Where the data cannot be obtained directly by the Prince Albert Satellite Station, CCRS will order it from NOAA through the EROS Data Center, (EDC) and will ship the data to the customer. Billing will be from CCRS at the established Canadian prices. The turn-around of orders from EDC is good.

Thematic Mapper

Thematic Mapper data products are not yet available on a production basis. However, CCRS has a number of Canadian 1982 fall and winter scenes on High Density Digital Tape (HDDT), and hopes to obtain additional Canadian coverage now in archive at NASA. A limited number of such HDDTs can be converted to Computer Compatible Tapes through the CCRS Thematic Mapper Transcription System.

TM products will not be on the market until next spring following the launch of LANDSAT-D'. However, in order to give users an opportunity to work with the data, CCRS is engaged in a LANDSAT-D Image Data Quality Analysis (LIDQA) program. The purpose of the program is to verify the quality and utility of TM data acquired over Canada and processed here. To participate in the program, a user must prepare a brief proposal, outlining an analysis or assessment project using a selected TM scene. The proposal should state that the user 1) will provide regular written reports on the progress and findings of the study; 2) will not copy or further distribute the data; and 3) will pay the $375 NOAA distribution fee for each scene (and/or sub-scene) supplied.

Considering that the data available only covers the fall and winter of 1982 and may have cloud cover, users should order and study an MSS scene of the same date and area to be sure that the TM product will be useful, before submitting a proposal.

The proposal, which can be in the form of a brief letter, should be sent to:

Dr. W. Murray Strome
Director, Digital Methods Division
Canada Centre for Remote Sensing
2464 Sheffield Road
OTTAWA, Ontario, Canada
K1A 0Y7

The TM data provided will only include systematic corrections. A list of TM scenes now held on HDDTs at CCRS appears on the next page. A supplementary list providing additional scenes will be published when the tapes have been received from NASA. A TM coverage map will also be published, showing those areas for which scenes are available with low cloud cover.

Data will not be available under the terms of the LIDQA program after the launch of LANDSAT-D' and the establishment of a price list for TM products. It is expected that Canadian prices will be similar to those charged by NASA.

Canadian TM Scenes in Archives, Prince Albert Satellite Station

(1)	(2)	(3)*	(4)*
11-19	25/01/83	40193-14452	0%
20	25/01/83	40193-14454	0%
21	25/01/83	40193-14460	55%
22	25/01/83	40193-14463	100%
23	25/01/83	40193-14465	100%
24	25/01/83	40193-14472	95%
25	25/01/83	40193-14474	55%
26	25/01/83	40193-14480	90%
27	25/01/83	40193-14483	98%
28	25/01/83	40193-14485	100%
29	25/01/83	40193-14492	98%
12-18	16/01/83	40184-14510	5%
19	16/01/83	40184-14512	10%
20	16/01/83	40184-14514	5%
21	16/01/83	40184-14521	0%
22	16/01/83	40184-14523	0%
23	16/01/83	40184-14530	2%
24	16/01/83	40184-14532	20%
25	16/01/83	40184-14534	95%
26	16/01/83	40184-14541	100%
27	16/01/83	40184-14543	100%
28	16/01/83	40184-14550	100%
29	16/01/83	40184-14552	100%
13-17	23/01/83	40191-	
18	23/01/83	40191-	
19	07/01/83	40175-	
19	23/01/83	40191-	
20	07/01/83	40175-	
20	23/01/83	40191-14580	15%
21	07/01/83	40175-	
21	23/01/83	40191-14583	65%
22	07/01/83	40175-	
22	23/01/83	40191-14585	90%
23	07/01/83	40175-	
23	23/01/83	40191-14592	50%
24	07/01/83	40175-	
24	23/01/83	40191-14594	45%
25	07/01/83	40175-	
25	23/01/83	40191-15000	15%
26	07/01/83	40175-	
26	23/01/83	40191-15003	20%
27	07/01/83	40175-	
27	23/01/83	40191-15005	30%
28	07/01/83	40175-	
28	23/01/83	40191-	
29	07/01/83	40175-	
29	23/01/83	40191-	
14-19	14/01/83	40182-	
20	14/01/83	40182-	
21	29/12/82	40166-15035	100%
21	14/01/83	40182-15043	60%
22	29/12/83	40166-15042	100%
22	14/01/83	40182-15045	50%
23	29/12/82	40166-15044	100%
23	14/01/83	40182-15051	90%
24	29/12/82	40166-15050	95%

(1) Picture centre number

(2) Date recorded (DD/MM/YY)

(3) Frame identification (MDDDD-HHMMS)

(4) Cloud percentage

* (Blank) Data exist but HHMMS and cloud percentage are not specified

Remote Sensing Information On-line

The REmote Sensing On-line Retrieval System (RESORS) is a computerized information service which provides free and rapid access to bibliographic references relating to the techniques, instrumentation, and applications of remote sensing, photogrammetry and image analysis. RESORS maintains a comprehensive collection of reports, journals and symposia literature, primarily in English and French, with a small collection of foreign reports.

Literature is selected for inclusion in RESORS if it deals directly with 1) the observation, from a distance, of the atmosphere or earth surface environments, or 2) the processing and analysis of the data collected. Each document entered in RESORS is then indexed from the full text of the document using controlled subject keywords that are assigned values reflecting their specific importance in the document. This allows references to be correlated (% relevance) against a user's search description.

Requests for information can be received by telephone or mail. To make a RESORS request: 1) write a brief but explicit description of your specific interest and/or 2) describe your area of interest by suggesting a list of keywords and category codes. There are over 1600 keywords in the RESORS dictionary which is available free upon request. Users with a terminal can also access RESORS through direct dialing or via the DATAPAC network. For search request or further information, contact:

RESORS
Canada Centre for Remote Sensing
240 Bank Street, 5th Floor
Ottawa, Ontario, K1A 0Y7
(613) 995-5645

Meetings/Conferences/Courses

January - March 1984

URSI Specialist Meeting on Microwave Signatures in Remote Sensing
January 16-20, 1984
Toulouse, France

Course: Digital Image Processing of Earth Observation Sensor Data
February 13-17, 1984
George Washington University
San Diego, CA

Course: Applying Remote Sensing Techniques to the Marine Environment
February 13-17, 1984
George Washington University
San Diego, CA

Twelfth Alberta Remote Sensing Course
February 20-24, 1984
Alberta Remote Sensing Center
Edmonton, Alberta

G.D.T.A. Remote Sensing Training Cycle
February 20 - March 16, 1984
Toulouse, France

Course: Technical Photography for Reproduction of Remotely Sensed Imagery
March 5 - May 25, 1984
RSI and South Dakota State University
Brookings, SD

ASP-ACSM Convention: Technology in Transition
March 11-16, 1984
Washington, D.C.

International Conference on Acoustics, Speech and Signal Processing (ICASSP)
March 19-21, 1984
IEEE
San Diego, CA

April - June 1984

Conference on Quantitative Remote Sensing in the Earth Sciences
April or May, 1984
Remote Sensing Society
Reading, UK

Satellite-aided search and rescue
April 9-14, 1984
CNES
Toulouse, France

Third Thematic Conference on Remote Sensing for Exploration Geology
April 16-19, 1984
ERIM
Colorado Springs, CO

G.D.T.A. Remote Sensing Training Cycle
May 7 - June 22, 1984
Toulouse, France

G.D.T.A. Remote Sensing Training Cycle
May 14 - June 8, 1984
Toulouse, France

37th Annual Conference on Image Technology
May 20-24, 1984
SPSE
Boston, MA

3rd Australasian Remote Sensing Conference (Landsat 84)
May 21-25, 1984
Surfers Paradise, Australia

International Microwave Symposium and Workshops
May 30 - June 1, 1984
IEEE
San Franscisco, CA

Conference on Satellite Meteorology/Remote Sensing and Applications
June 1984
American Meteorological Society
Tampa, Florida

IGARSS'84
June 4-8, 1984
DFVLR
Innsbruck, Austria

10th International Symposium on Machine Processing of Remotely Sensed Data
June 12-15, 1984
IEEE/LARS Purdue
W. Lafayette, IN

15th Congress of the International Society for Photogrammetry and Remote Sensing (ISPRS '84)
June 17-29, 1984
Rio de Janeiro, Brasil

Conference on Lasers and Electro-Optics (CLEO '84)
June 18-22, 1984
OSA
Anaheim, CA

Ninth International Codata Conference
June 24-27, 1984
International Council of Scientific Unions
Jerusalem, Israel

International IEEE Antennas and Propagation Symposium and USNC/URSI Meeting
June 25-29, 1984
Boston, MA

COSPAR 25th Plenary Meeting
June 25 - July 7, 1984
Graz, Austria

July - September 1984

International Conference on Inventorying Forest and Other Vegetation of the High Latitude and High Altitude Regions
July 23-26, 1984
SAF, IUFRO
Fairbanks, Alaska

Seventh International Conference on Pattern Recognition
July 30 - August 2, 1984
Montreal, Quebec

9th Canadian Symposium on Remote Sensing
August 1984
St. John's, Newfoundland

1984 International Conference on Information Processing in Optics
August 15-17, 1984
Christchurch, New Zealand

IAHR Symposium on Ice
August 27-31, 1984
Hamburg, W. Germany

Remote Sensing Society Annual Technical Conference: Remote Sensing, Views and Pre-views
September 18-21, 1984
University of Reading
Reading, UK

G.D.T.A. Remote Sensing Training Cycle
September 24, 1984 - June 20, 1985
Toulouse, France

October - December 1984

18th International Symposium on Remote Sensing of Environment
October 1-5, 1984
ERIM
Paris, France

G.D.T.A. Remote Sensing Training Cycle
October 1-26, 1984
Toulouse, France

IUFRO Symposium on Forest Management Planning and Managerial Economics
October 15-19, 1984
University of Tokyo
Tokyo, Japan

9th Annual International Conference on Infrared and Millimeter Waves
October 22-26, 1984
IEEE
Takarazuka City, Japan

International Symposium on Clutter in Radars and Imaging Sensors
October 23-25, 1984
IEEE
Tokyo, Japan

Optical Society of America Annual Meeting
October 29-November 2, 1984
OSA
San Diego, CA

Fifth Asian Conference on Remote Sensing
November 3, 1984
India

For further information contact:

Canada Centre for Remote Sensing, TIS (Lidia Taylor), 240 Bank Street, 5th Floor, Ottawa, Ontario, K1A 0Y7
tel.: (613) 995-5645