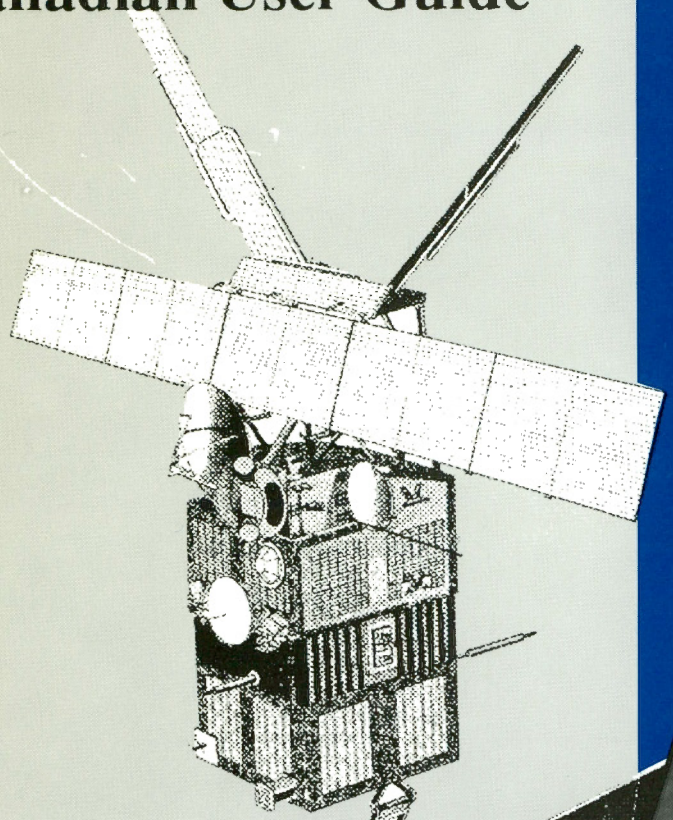
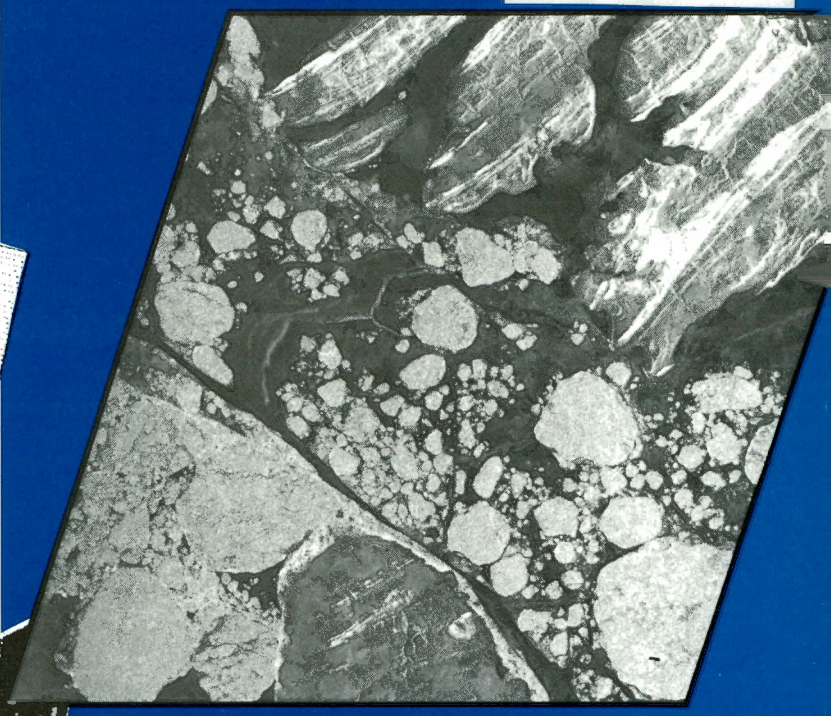
ERS-1

Canadian User Guide

CANADA CENTRE FOR REMOTE SENSING
Surveys, Mapping and
Remote Sensing Sector

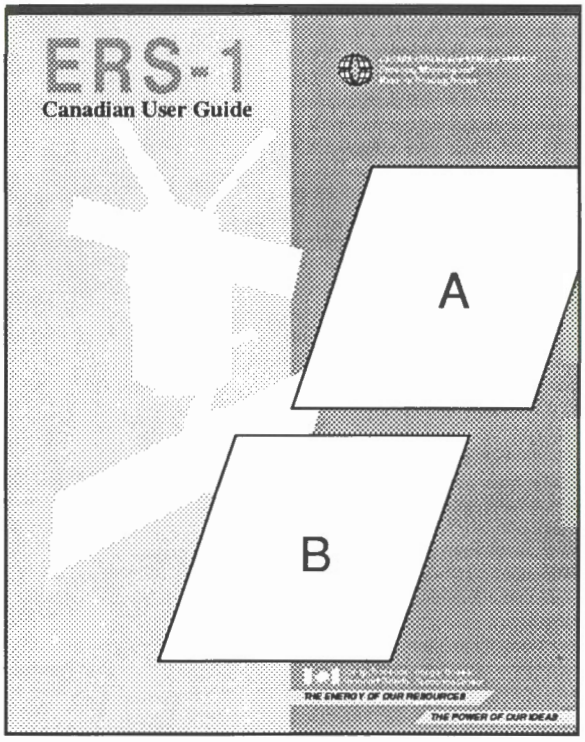




Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

THE ENERGY OF OUR RESOURCES

THE POWER OF OUR IDEAS



A- Image used for navigation in the Arctic.
B- Agriculture area in southern Ontario.

Canada

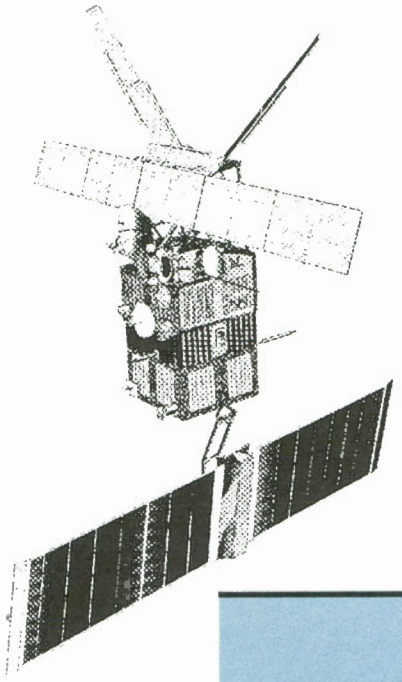


TABLE OF CONTENTS

1. INTRODUCTION

On July 17, 1991, the European Space Agency (ESA) launched its first remote sensing satellite ERS-1 from the ELA 2 launch facility at Kourou, in French Guyana. ERS-1 has a projected lifespan of two to three years and its successor ERS-2 will provide data for a further two to three years. Canada is a full participant in the ERS-1 program and is part of the ESA network of receiving and processing stations.

The Canada Centre for Remote Sensing coordinates all Canadian requests for ERS-1 data and receives, records and processes the data into usable products for distribution. This guide is intended for users of these data products from ERS-1.

2. ERS-1 BACKGROUND

Canada joined the ESA's Remote Sensing Preparatory Programme in 1980 and subsequently became a full participant in the design, construction and operation of ERS-1. The Canadian Government assumed a 6.1% share (now 6.26%) of the design and construction phases, and a 7.64% share (now 7.30%) of the operation phase.

In return, Canadian industry gained a proportionate share of contracts for the spacecraft and for the ESA-financed ground segment. Canada also gained the right to receive ERS-1 data in Canada for Canadian government approved purposes, subject to ESA's allocation rules.

ESA issued an Announcement of Opportunity (AO) to researchers world-wide, inviting them to submit proposals for the use of ERS-1 data. Several Canadian investigators were successful and are now participating in ESA approved projects under nominated Coordinating Investigators. ESA has committed to provide approved AO investigators with reasonable amounts of data at no charge. In June 1992, ESA issued a second request for proposals for projects whose objectives are to demonstrate the use of ERS-1 data in operational applications. Again, ESA has agreed to provide data free of charge to approved investigators, as well as to organize technical meetings for information exchange.

The Canada Centre for Remote Sensing (CCRS) issued a separate AO to better allow Canadian researchers to participate in ERS-1 activities.

The ERS-1 payload includes five instruments, namely a Laser Retro Reflector (LRR), the Precision Range and Range Rate Equipment (PRARE), an Active Microwave Instrument (AMI) for C-band SAR imagery, wave spectra measurements and wind scatterometry over oceans, an Along-Track Scanning Radiometer (ATSR) consisting of a microwave sounder and of an infrared radiometer, and finally a nadir-looking Ku-band radar altimeter used for altitude measurements.

ESA's Earthnet organisation distributes Fast Delivery products from the ERS-1 instruments within three hours of data acquisition (ref. 1). In Canada, CCRS has developed a SAR processing facility to provide SAR image products to Canadian users. The ESA Fast Delivery Products from the non-imaging instruments are available to Canadian users through the Atmospheric Environment Service (AES) as described in section 6.3.

ESA archives all their products, including copies of the fast delivery products, at four Processing and Archiving Facilities (PAF), in Europe. Canadian users can request archived products directly from these facilities.

CCRS operates two satellite receiving stations in Canada, in Prince Albert, Saskatchewan and in Gatineau, Quebec. Together, they provide full coverage of North America (Figure 2-1) and both stations were upgraded to receive ERS-1 data.

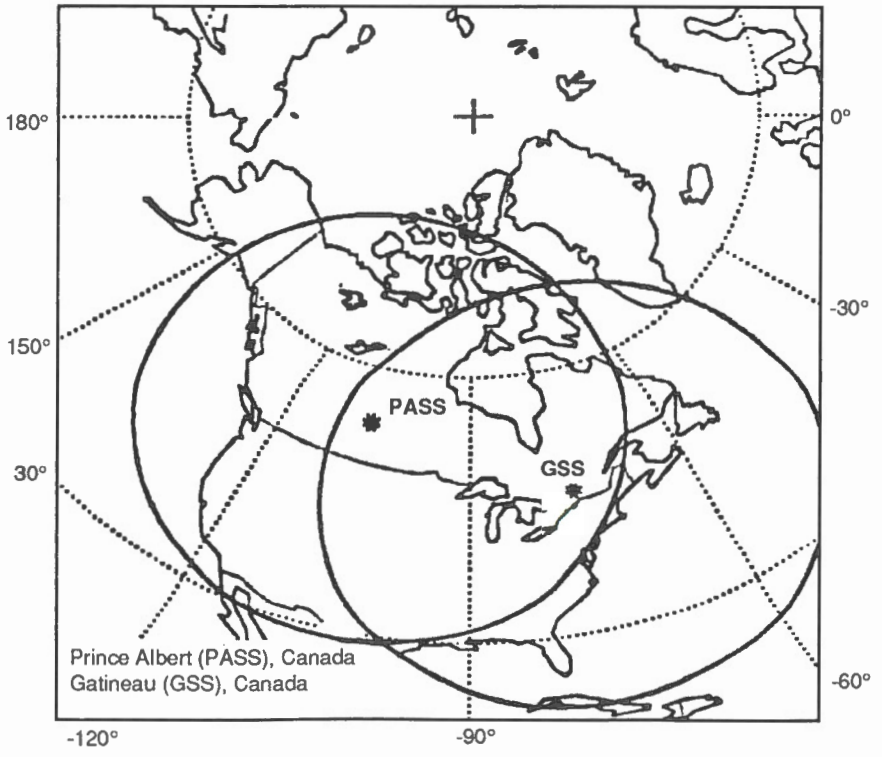
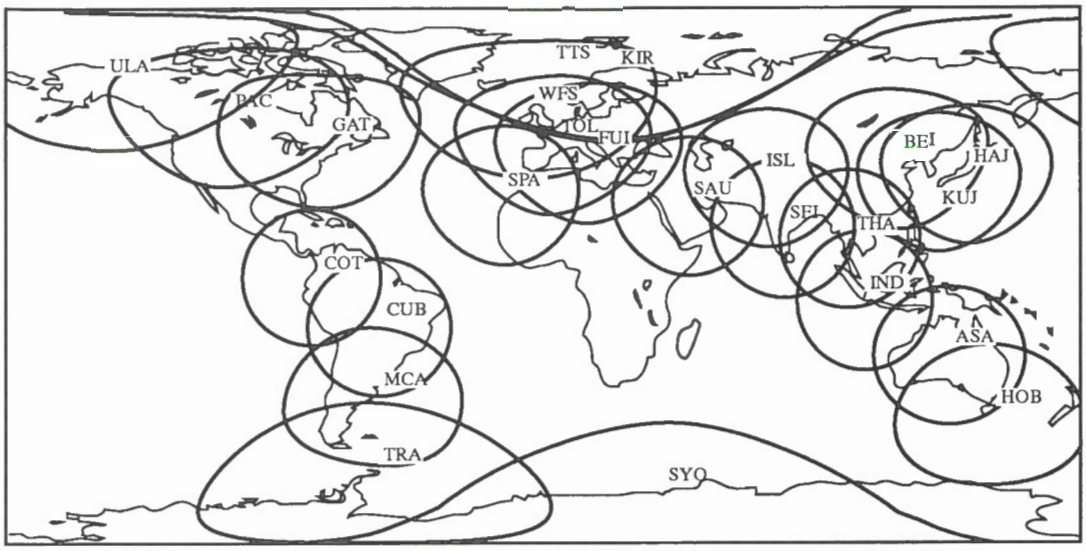


Figure 2-1 Coverage of North America



ASA	Alice Springs, Australia
BEI	Beijing , China
COT	Cotopaxi, Ecuador
CUB	Cuiba, Brazil
FUI	Fucino, Italy
GAT	Gatineau, Canada
HAJ	Hatoyama, Japan
HOB	Hobart, Australia
IND	Jakarta, Indonesia
ISL	Islamabad, Pakistan
KIR	Kiruna, Sweden
KUJ	Kumamoto, Japan
MCA	Mar Chiquita, Argentina
PAC	Prince Albert, Canada
SAU	Riyahd, Saudi Arabia
SEI	Secunderabad, India
SPA	Maspolomas, Spain
SYO	Showa, Japan/Antartica
THA	Bangkok, Thailand
TGS	Greenbelt USA
TOL	Aussaguel, France
TRA	Esperanza, Argentina/Antartica
TTS	Tromsö, Norway
ULA	Fairbanks, Alaska
WFS	West Freugh, UK.

Figure 2-2 Worldwide ERS-1 coverage is ensured by a network of receiving stations

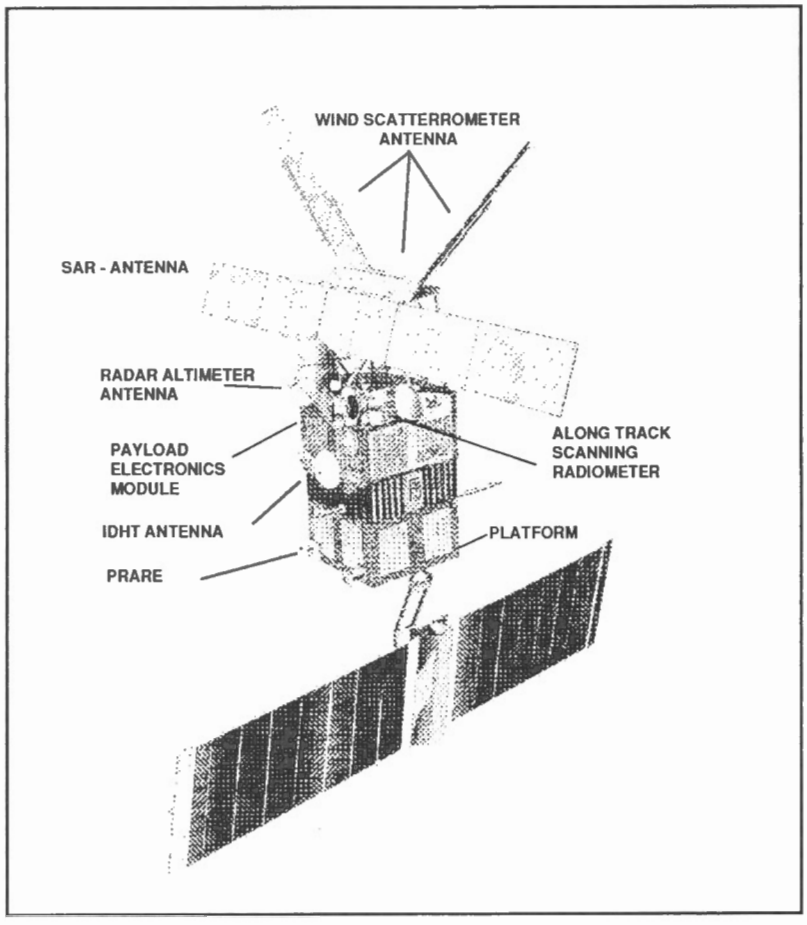


Figure 3.1 ERS-1 Satellite

3. DESCRIPTION OF INSTRUMENTS

ERS-1 carries three principal instruments (Figure 3-1):

- The C-Band Active Microwave Instrumentation (AMI) comprising side-looking radar systems with three in-flight selectable modes: for high-resolution imaging (SAR); for measurements relating to wave spectra (WAVE); and for wind scatterometry (WIND) over the ocean surface.
- The Ku-Band Radar Altimeter (RA), a nadir looking instrument for altitude measurements.
- The Along-Track Scanning Radiometer (ATSR), a passive instrument consisting of an infrared radiometer and a Microwave Sounder (MWS), both of which can be operated at the same time.

Two more devices on board the satellite (Figure 3-1) require no ground station processing:

- The Precision Range and Range Rate equipment (PRARE) and
- The Laser Retro Reflector

3.1 The Active Microwave Instrumentation AMI

The AMI can operate in one of three modes: IMAGE, WAVE or WIND. Only one of these modes can be selected at any given time. Total operation time in IMAGE mode is limited to approximately 8 minutes per orbit because of power constraints. Each data-take must last at least one minute.

WIND and WAVE modes can be interleaved to provide snap-shot WAVE data at regular intervals.

3.1.1 AMI IMAGE mode

The AMI IMAGE Mode produces high-resolution radar images of the Earth's surface. In this mode, the instrument operates as a Synthetic Aperture Radar (SAR). A swath of approximately 100 km is illuminated to the side of the satellite (see Figure 3-2 and 3-3). This high-resolution imaging requires both high power and a high data rate, precluding on-board storage and prolonged measurement. Image mode operations are therefore performed only while in line-of-sight communication with an ERS-1 ground receiving station. AMI IMAGE mode data are received and processed in Canada by CCRS.

3.1.2 AMI WAVE mode

The function of WAVE mode is to measure the radar reflectivity of the sea surface as it is influenced by ocean waves.

In WAVE mode, the input signals and the target area in both the along-track and across-track directions are reduced from those of the IMAGE mode. This reduces the output data rate to enable on-board storage of the wave data.

The data acquired are first processed as in the SAR IMAGE mode, except that there is no Doppler Ambiguity Estimator. In a second step, the wave image is converted to a spectrum of the SAR image, representing the wave information.

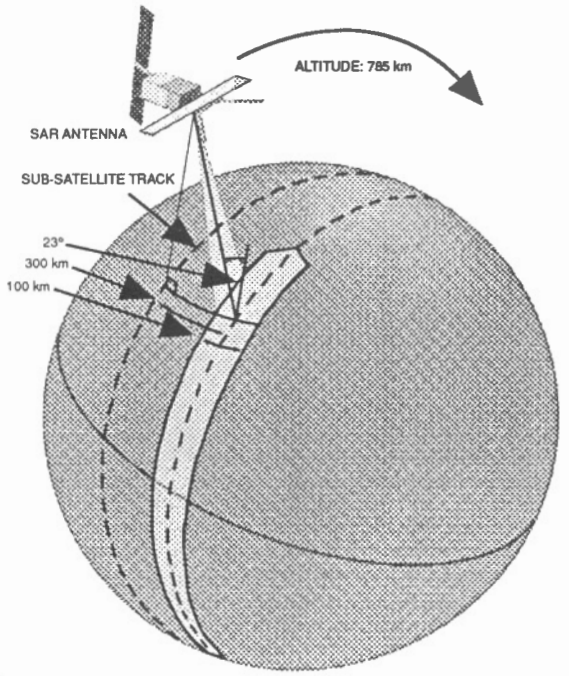


Figure 3-2

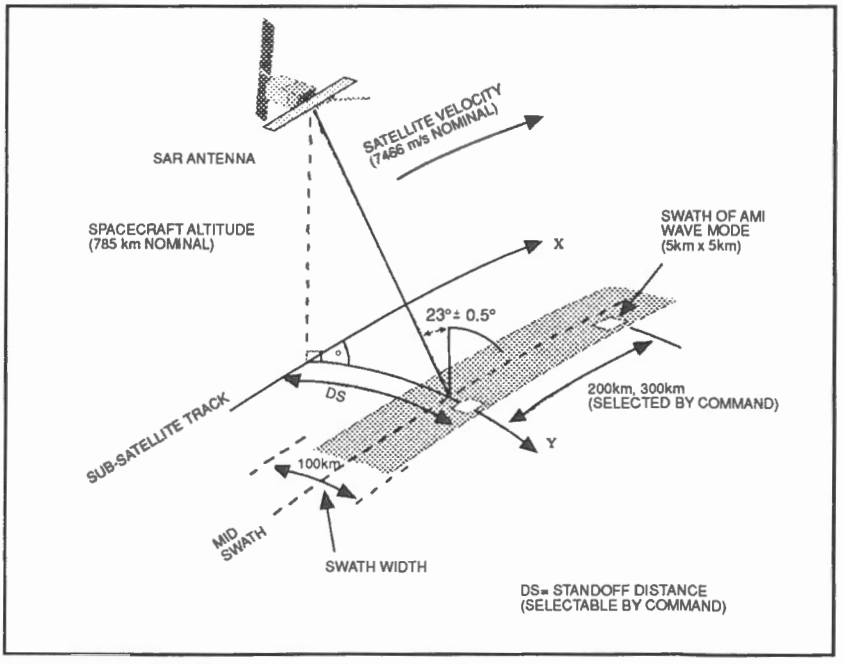


Figure 3-3

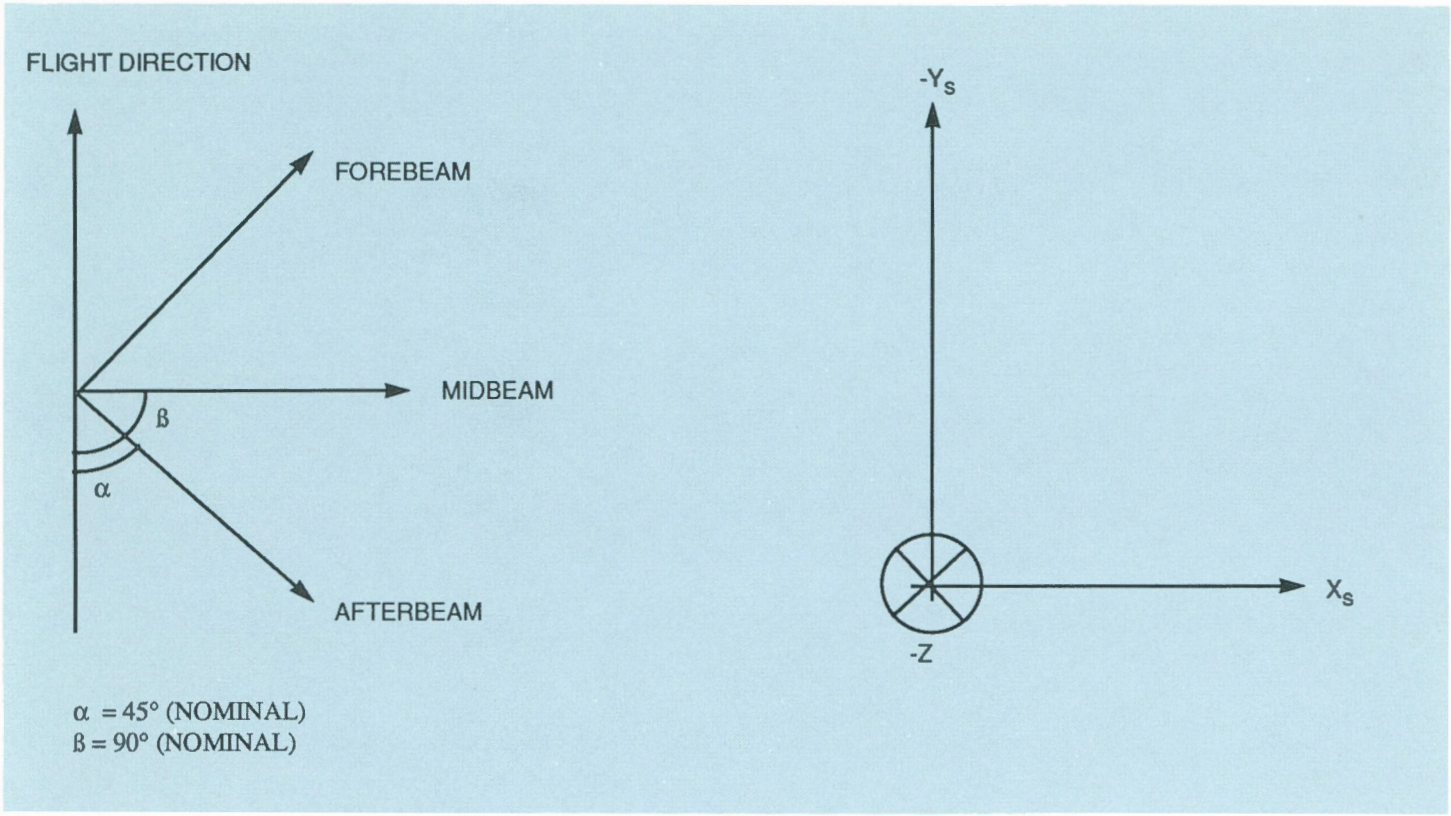


Figure 3-4 Scatterometer Antenna Orientations

3.1.3 AMI WIND mode

In the AMI WIND mode (scatterometer) the sea surface is sequentially illuminated by RF pulses and the backscattered signal is measured to determine the average radar reflectivity of the sea surface. This is a non-imaging mode. The wind characteristics are determined by using a model that relates wind speed and wind direction relative to the radar beam to sea surface reflectivity. Unambiguous wind measurements require that each ocean patch is illuminated from at least three different directions. This is achieved by using three antennas, one looking sideward (midbeam antenna), one looking 45° forward (forebeam antenna), and one looking 45° aftward (aftbeam antenna) with respect to the spacecraft flight direction (Figure 3-4). All three antennas form a fan beam with a narrow azimuth pattern and a relatively wide elevation pattern in order to cover a wide swath (measurement area approximately 500 km) parallel to the subsatellite track (Figure 3-5).

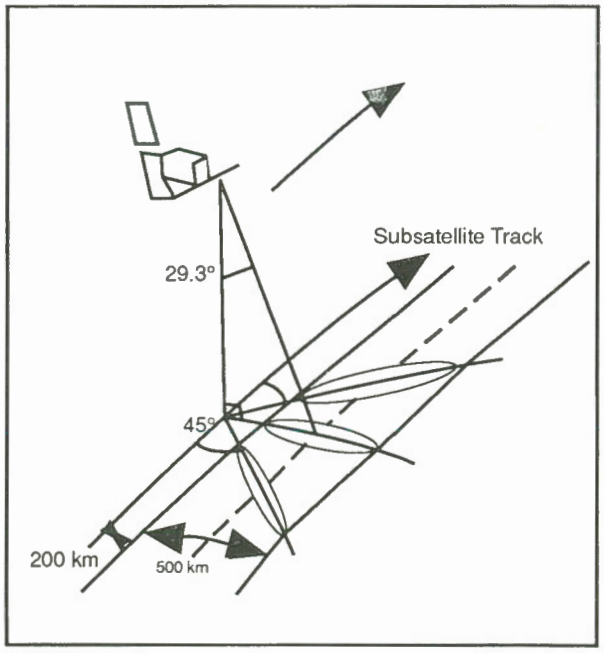


Figure 3-5 Geometry of AMI in WIND mode

A regular grid of points, named measurement nodes, is defined within the swath, spaced at 25 km across track and approximately 25 km along track. Wind speed and direction can be calculated from either two or three beams. The number of beams used is indicated for each node (Figure 3-6).

The conversion from sigma nought to wind speed and direction gives an ambiguous result. In a second step, an attempt is made to remove the ambiguity. If that is not possible, it is indicated in the output product and the most likely solution is given.

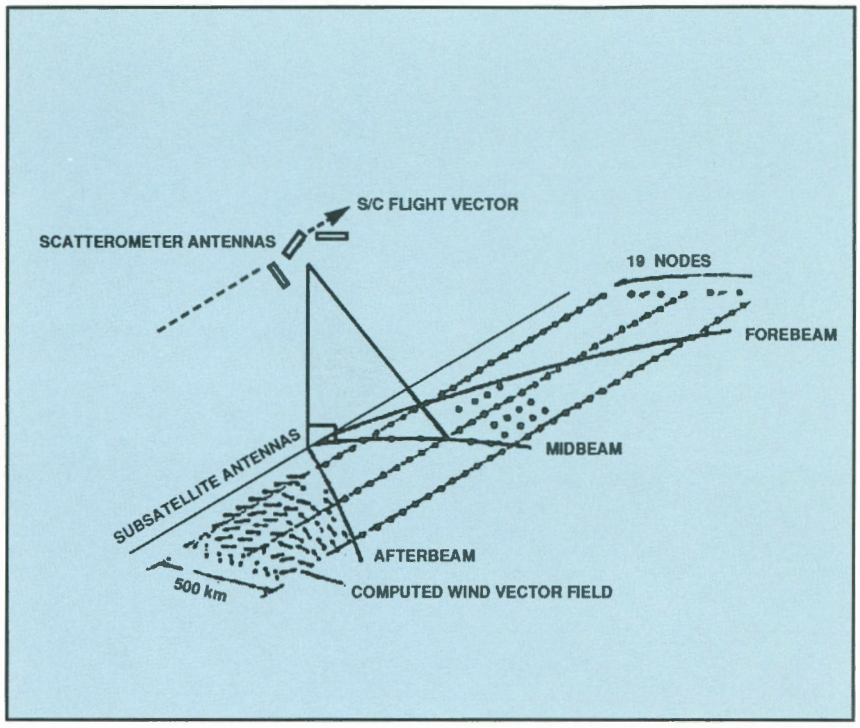


Figure 3-6 Scatterometer System Geometry

3.2 Radar altimeter

The Radar Altimeter (RA) of the ERS-1 is a nadir-looking active microwave instrument, which operates over the ocean and over ice. Over the ocean, it is used to determine the significant wave height, the wind speed and the mesoscale topography. Over ice, it is used to determine the ice surface topography and ice type.

The microwave measurements comprise the time delay between transmission and reception of a pulse, the slope of the leading edge of the return pulse, the amplitude of the return pulse and the echo waveforms.

These measurements are used as follows:

- The altitude is determined from the measured delay time between transmission and reception of the pulse, (after correction of propagation delays caused by ionosphere and troposphere).
- The Significant ocean Wave Height (SWH) is calculated from the slope of the eading edge of the return echo.
- The wind speed over sea surfaces is estimated from the power level of the backscatter signal.

3.3 Along Track Scanning Radiometer (ATSR)

The Along-Track Scanning Radiometer and Microwave Sounder (ATSR) is a passive instrument consisting of an advanced four-channel infrared radiometer and a two-channel nadir viewing microwave sounder. Unlike the other ERS-1 instruments, the ATSR is an experimental package resulting from an ESA Announcement of Opportunity for a scientific add-on payload package.

The raw ATSR data will be sent to the Rutherford Appleton Laboratory (RAL), UK, for further processing via the UK-PAF, one of the recipients of the Low Bit Rate (LBR) raw data coming from the ERS-1 Ground Stations. Ground Stations may send extracted raw ATSR data on CCT directly to the RAL when requested.

The product will be generated by the RAL and will consist of sea surface temperature images and cloud top temperatures. The Infra-Red (IR) measurements will be corrected for atmospheric influence using the microwave measurements and the two-atmospheric-path method: the 45° forward view and the nadir view.

4. ORBIT PHASES

ERS-1 will operate in three different sun-synchronous orbits during its lifespan. In early April 1992 the satellite was brought into its "Multi-disciplinary Phase" which has a 35 day repeat cycle. The latter phase allows a wider spatial coverage, especially at lower latitude. There are plans for transition back to three day repeat orbit and to a final 176-day orbit at the end of the mission (Figure 4-1). There is a maximum of six orbit modifications possible in the lifespan of ERS-1 because of fuel budget constraints.

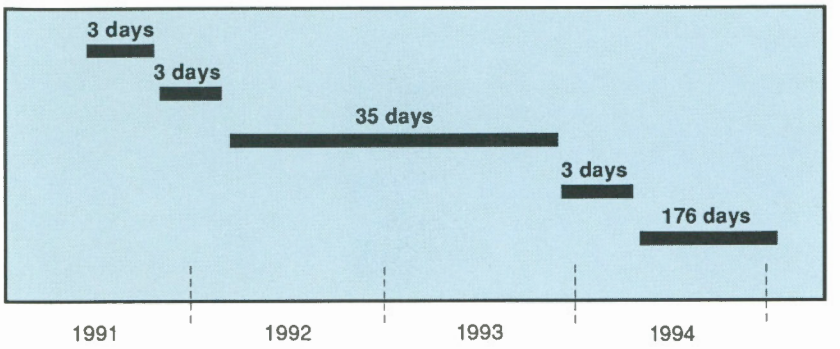


Figure 4-1 ERS-1 orbits schedule

4.1 Commissioning phase, reference orbit

The first ERS-1 orbits were those of the "Commissioning Phase" which had a three day repeat cycle. The purpose of this phase was to allow intensive campaigns to test and validate the ERS-1 data, to calibrate instruments with field activities and to allow processing facilities to collect and process data. The characteristics of the reference orbit and of the other orbits are described in Table 4-1. This phase was officially concluded December 10, 1991.

Characteristic	Commissioning phase	Multi-disciplinary phases	Ice phases
repeat cycle	3 days	35 days	3 days
semi-major axis	7153.138	7159.496	7153.138
inclination	98.516	98.543	98.516
average altitude	785 km	782 km	785 km
orbits per cycle	43	503	43
Descending node local equator crossing time	10:30	10:30	10:30
Reference ascending node longitude	24.36E	20.96E	128.2W

Table 4-1: Characteristics of ERS-1 operating orbits.

4.2 Ice orbit

The manoeuvres to bring the platform into its first "Ice Phase" began December 13, 1991 and were completed December 23, 1991. This phase has a three day repeat cycle. It is designed to provide a good temporal and spatial coverage of higher latitudes to monitor ice movement, particularly for Arctic ice experiments. A second ice phase of 3-day repeat orbits is planned to start at the end of 1993 and to last for approximately three months. The ground coverage provided by this repeat cycle is illustrated in Figure 4-2.

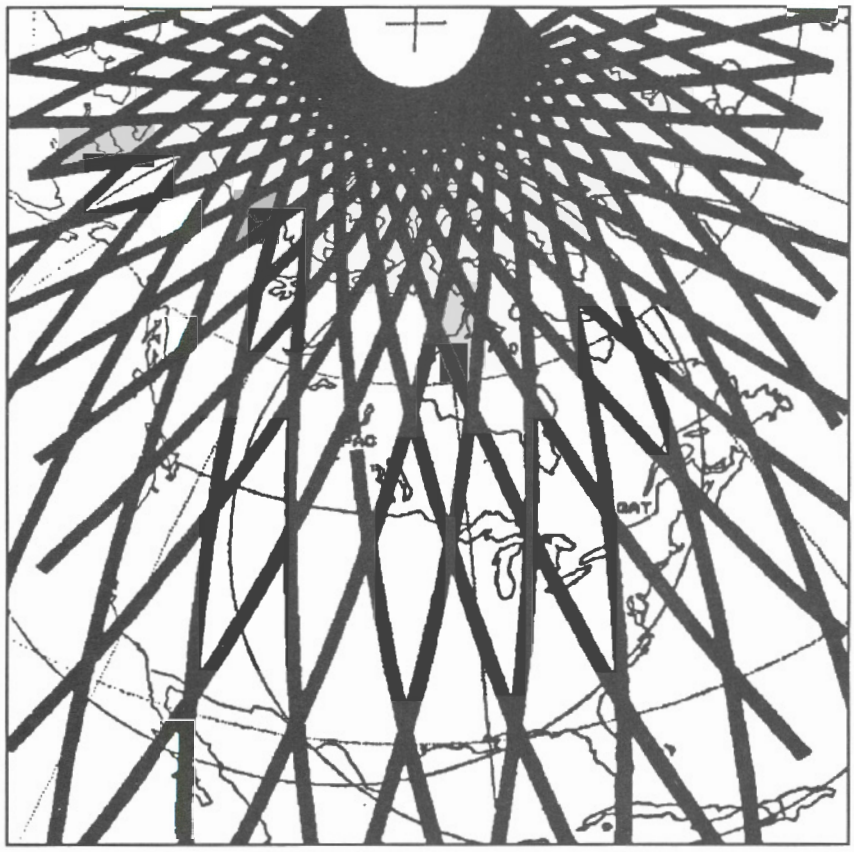


Figure 4-2 Ground coverage obtained from a 3 day repeat cycle

4.3 Multi-disciplinary phase

This 35 day orbit phase accounts for the major part of the ERS-1 mission. This repeat cycle provides full SAR imaging of the Earth's surface. Objectives of this phase include determination of reference mean sea surface, support of all land applications, particularly AO experiments, agricultural and forestry projects and tropical forest mapping.

4.4 176-day Orbit Cycle

Measurements of mean sea surface and of ocean geoid require this repeat cycle to provide a very high density of altimeter tracks. The very long repeat cycle conflicts with mission requirements in other disciplines and will only be carried out at the end of the ERS-1 mission.

5. THE CANADIAN GROUND SEGMENT

The Canadian Ground Segment is a CCRS responsibility. Facilities have been developed over the last twenty years in response to Canadian demand for data from a growing number of remote sensing satellites. These facilities are owned by the government and are operated by CCRS.

At present, the ground segment consists of data acquisition stations at Prince Albert, Saskatchewan and at Gatineau, Quebec, with processing facilities in Vancouver and in Ottawa. Data is currently acquired from ERS-1, SPOT, NOAA, EXOS-D, LANDSAT and MOS-1. CCRS is now upgrading the ground segment in preparation for RADARSAT. A second 10m tracking antenna was added at both Prince Albert and at Gatineau, and an annex was built at Gatineau to accommodate the Canadian SAR processing facility. Figure 5.1 shows the ground segment layout. The antenna locations (Table 5-1) are as follows:

	Gatineau August 1989 survey	Prince Albert
Site #1, SPOT LANDSAT		
Altitude Latitude Longitude	290 m N 45° 34' 52.6" W 75° 48' 22.3"	478 m N 53° 12' 39.0" W 105° 55' 41.0"
Site #2, ERS-1		
Altitude Latitude Longitude	292 m N 45° 34' 52.7" W 75° 48' 22.3"	479.9 m N 53° 12' 45.4" W 105° 56' 00.7"

Table 5-1 The antenna location

The Canadian SAR processing facility consists of a suite of computer equipment designed to process raw SAR data into usable images. The equipment also provides management facilities such as catalogue maintenance, order entry and processing, and product distribution. SAR images are produced in swath format and are distributed to on-line users by the Image Transfer Network (ITN) on Megaroute, and to other users on computer compatible tape (CCT). An order desk is in place at CCRS for Canadian users to place orders for SAR image products.

CCRS also receives and processes data from the non-imaging ERS-1 instruments, the Low Bit Rate (LBR) data, as a service to ESA. CCRS does not sell these products directly to Canadian users, but will transmit them to ESA for world-wide distribution. In Canada, the Atmospheric Environment Service (AES) of Environment Canada accesses the LBR Fast Delivery Products from ESA at the NOAA (Washington) drop-off point for use in support of their weather and sea-state forecasting programs. Other Canadian users can access these data from the AES operational data distribution network in the same way as they access other meteorological data. Please note that not all of the LBR Fast Delivery data are available at all major nodes of the AES networks and that AES does not intend to archive the data.

Figure 5-1 illustrates the complete Canadian ground segment for ERS-1.

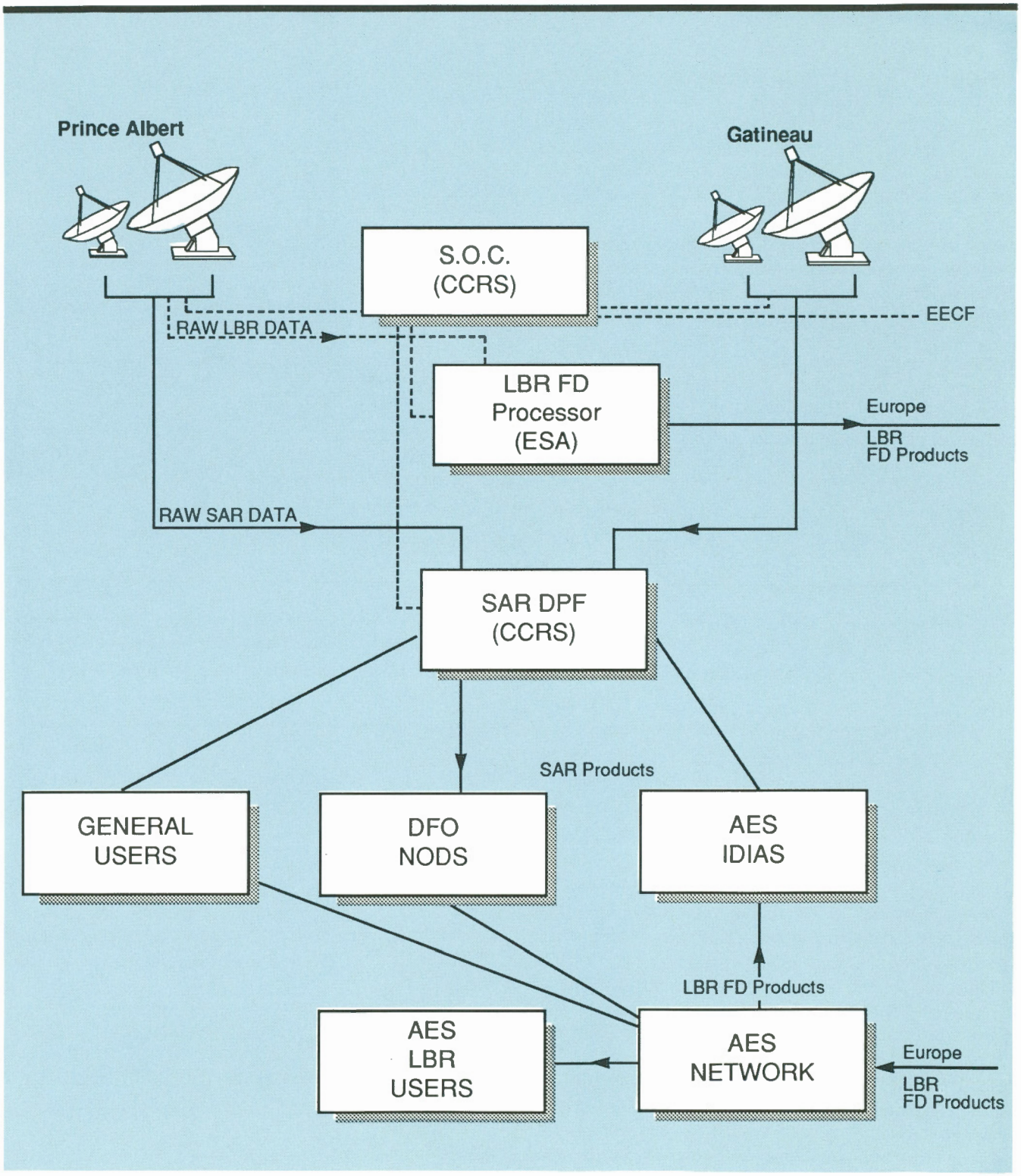


Figure 5-1 Canadian ground segment

6. ERS-1 PRODUCTS

SAR IMAGE mode products of areas within the coverage of the Canadian stations are produced by the CCRS SAR processing facility. These products are described below in more detail. Low Bit Rate (LBR) Products are available in two forms: as fast delivery products on the AES operational data distribution network, or as CCT products from European PAFs.

6.1 Canadian SAR Image Mode Products

SAR products are available in a variety of forms to suit different users.

- First-level products are georeferenced, which means that the image remains oriented along the track of the satellite and includes latitude and longitude information.
- Second-level products are system geocoded, which means that the image has been rotated and corrected to conform to a standard map projection.
- Third-level products are precision geocoded, which means that the image has been rotated and corrected by correlation with known ground control points (GCPs), and also corrected from a digital terrain model where available. Special products, such as complex images are also available from ERS-1 data.

The SAR products are available on computer compatible tape (CCT). The available SAR IMAGE mode products are described in tables 6-1 to 6-8 and examples are displayed in Figures 6-1 to 6-5.

A scene over Brandon, Manitoba was processed into five different products to illustrate their differences. The scene shows mostly agricultural areas and the city of Brandon in the lower right quadrant of the image.

ERS-1 SAR Product	Acronym	Figure
Georeferenced Fine-Resolution	SGF	6-1
Georeferenced Coarse-Resolution	SGC	6-2
Systematically Geocoded	SSG	6-3
Precision Geocoded	SPG	6-4
Single-Look Complex	SLC	X
Single-Look Detected	SLD	
Multi-Look Detected	MLD	6-5
Raw Data	RAW	X

X cannot be imaged

The following detailed product descriptions are based on CEOS (Committee on Earth Observation Satellites) formats for CCTs, where key parameters are located as fields within specified records for each product.

Each product description includes the values of key product-specific parameters. For detailed information concerning which fields are used within which records in CCT format, please consult document R3.

Pixel values within the SAR image products are represented in one of the following formats (specified for each product):

- 16-bit value, unsigned integer;
- a complex pair of 16-bit values, 2's complement;
- 8-bit value, unsigned integer.

For the RAW product, each complex signal value is represented as a pair of signed 8-bit integers.

Data are distributed on computer compatible tape (CCT) or over the Image Transfer Network (ITN). The latter is presently available only to the Canadian Ice Centre (Ottawa) of the Atmospheric Environment Services (AES) and Department of Fisheries and Oceans (DFO).

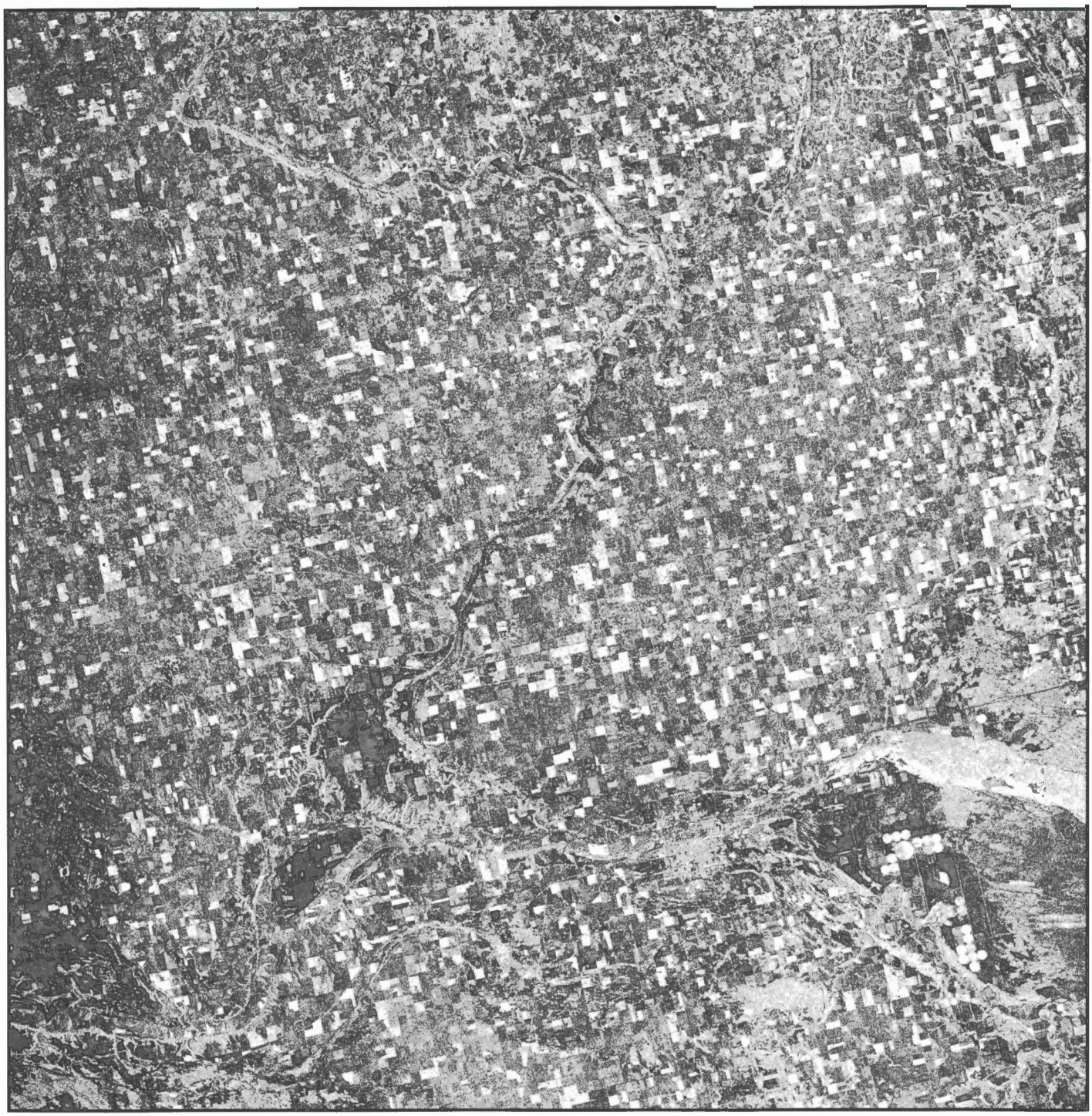


Figure 6-1 Georeferenced Fine-Resolution (SGF) product.

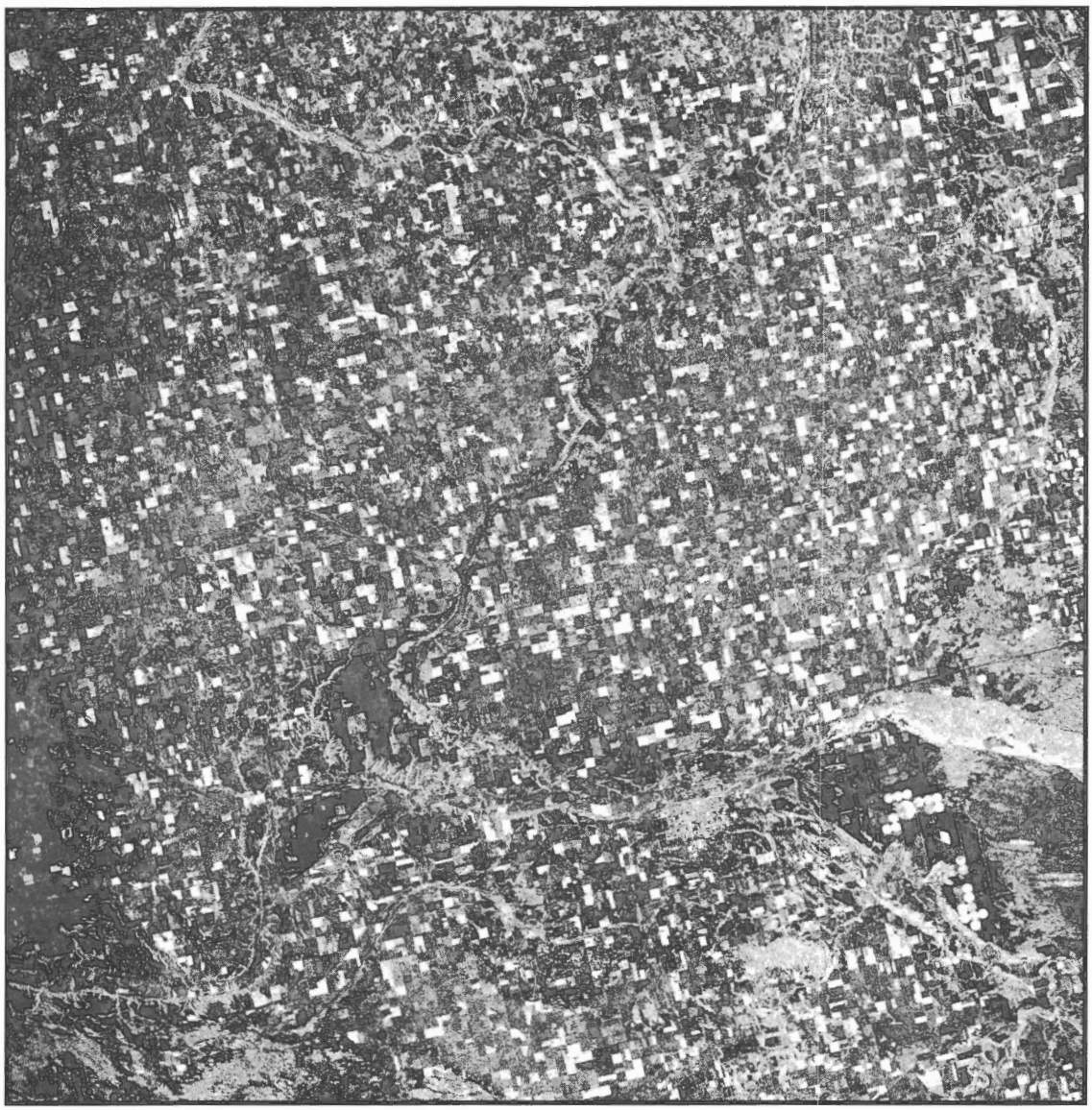


Figure 6-2 Georeferenced Coarse-Resolution (SGC) product.

ERS-1 SAR GEOREFERENCED FINE-RESOLUTION PRODUCT

The ERS-1 SGF product consists of fine-resolution, processed multilook SAR imagery from the ERS-1 satellite. The data has not been put in a map projection but is georeferenced by the addition of latitude and longitude information for each line in the image.

Table 6-1 ERS-1 SGF Product Parameters

Parameter	Value
coordinate system	zero Doppler, ground range
number of lines	8000 (image) variable swath
number of pixels	8000
spatial resolution	nominal 30m azimuth by 35 m ground range
absolute geometric accuracy (flat terrain)	1100m
relative geometric accuracy (flat terrain)	40m
number of processed looks	6
type of pixels	16-bit detected
pixel spacing	12.5m by 12.5m
distribution media	CCT,ITN

Table 6-1 gives the values of key product parameters for the ERS-1 SGF product. When sent over the ITN in the form of a swath, an ERS-1 SGF product consists of processed data records only. These records are formatted as shown in Document R3.

ERS-1 SAR GEOREFERENCED COARSE-RESOLUTION PRODUCT

The ERS-1 SGC product is a coarse-resolution form of the ERS-1 SGC product. As with its fine-resolution counterpart, this product consists of processed multi-look SAR imagery from the ERS-1 satellite. The data has not been put in a map projection but is georeferenced by the addition of latitude and longitude information for each line in the image.

Table 6-2 ERS-1 SGC Product Parameters

Parameter	Value
coordinate system	zero Doppler, ground range
number of lines	2000 (image) variable swath
number of pixels	2000
spatial resolution	nominal 100m azimuth by 100 m ground range
absolute geometric accuracy (flat terrain)	1100m
relative geometric accuracy (flat terrain)	50m
number of processed looks	96*
type of pixels	16-bit detected(image) 8-bit detected (swath)
pixel spacing	50m by 50m
distribution media	CCT,ITN

* After 4x4 averaging of ERS-1 SGF input data

Table 6-2 gives the values of key product parameters for the ERS-1 SGC product. When sent over the ITN in the form of a swath, an ERS-1 SGC product consists of processed data records only. These records are formatted as shown in Document R3.

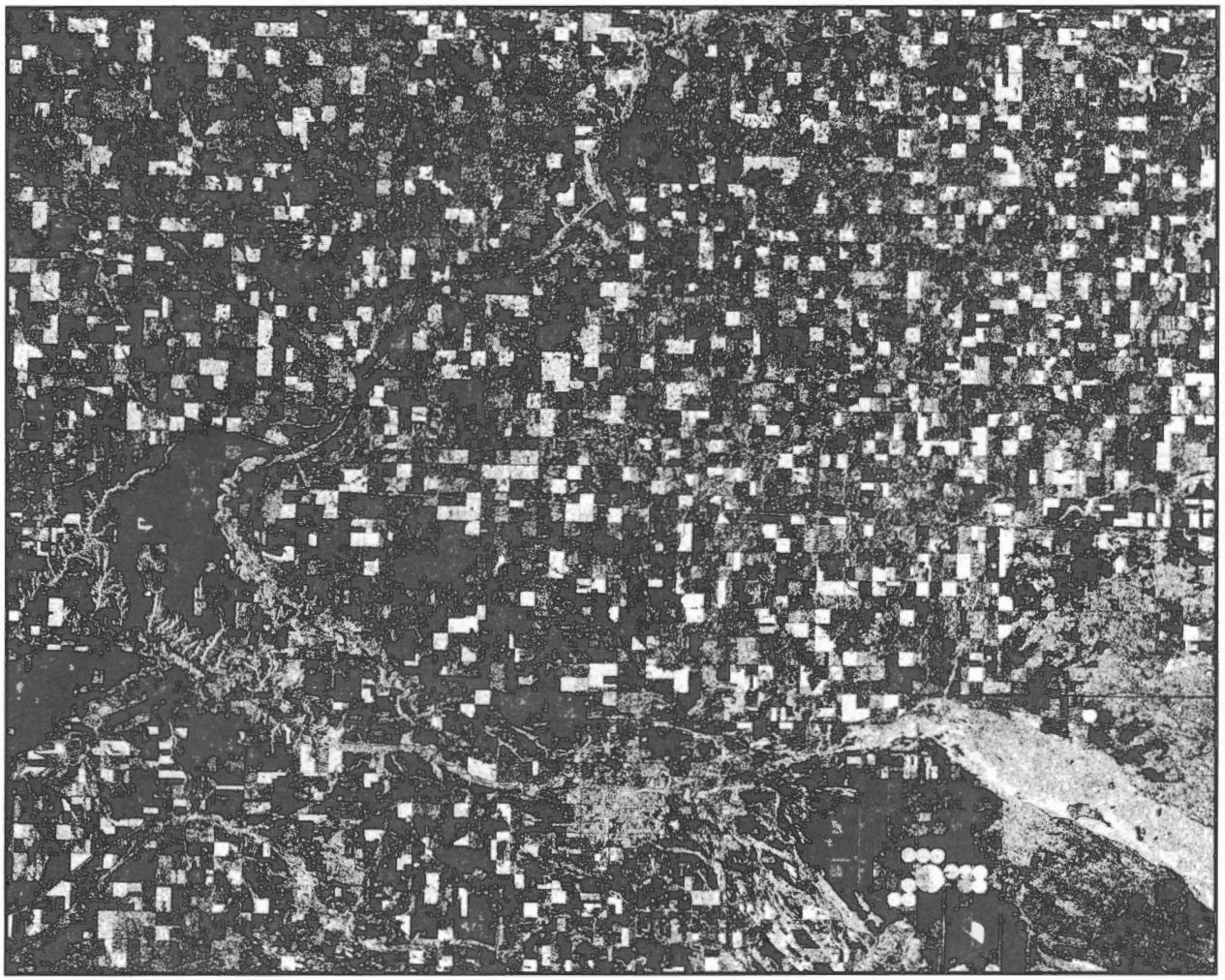


Figure 6-3 Systematically Geocoded (SSG) product.

ERS-1 SAR SYSTEMATICALLY GEOCODED PRODUCT

The ERS-1 SSG product consists of a systematically geocoded version of the high-resolution ERS-1 SGF product. The image data is processed multi-look SAR imagery from the ERS-1 satellite. A number of different map projections are possible during the geocoding process.

For the UTM projection, the exact image size is determined by the image location. Table 6-3 specifies both the nominal and maximum image sizes (as number of lines and number of pixels). For the Lambert Conformal and Polar Stereographic projections, the image size is independent of image location.

The locational accuracy (absolute and relative) of the ERS-1 SSG product is essentially the same as that for the ERS-1 SGF product because no Ground Control Points (GCPs) are used when the data is geocoded. The main difference between the two products is the coordinate system used to display the image data.

Table 6-3 ERS-1 SSG Product Parameters

Parameter	Value
map projections	UTM, Lambert Conformal, Polar stereographic
number of lines	UTM (nominal): 4432 UTM (maximum): 4480 Lambert conformal: 4000 or 1600 Polar stereographic : 8000
number of pixels	UTM (nominal): 6224 UTM (maximum): 6720 Lambert conformal: 4000 or 1600 Polar stereographic : 8000
spatial resolution	nominal 35m by 35 m
absolute geometric accuracy (flat terrain)	1100m
relative geometric accuracy (flat terrain)	40m
number of processed looks	6
type of pixels	8-bit detected
pixel spacing	12.5 m by 12.5 m
distribution media	CCT,ITN

* After 4 x 4 averaging of ERS-1 SGF input data

Table 6-3 gives the values of key product parameters for the ERS-1 SSG product.

ERS-1 SAR PRECISION GEOCODED PRODUCT

The ERS-1 SPG product is a precision geocoded version of the high-resolution ERS-1 SGF product. The image data is processed multi-look SAR imagery from the ERS-1 satellite. A number of different map projections are possible during the geocoding process.

For the UTM projection, the exact image size is determined by the image location. Table 6-4 specifies both the nominal and maximum image sizes (as number of lines and number of pixels). For the Lambert Conformal and Polar Stereographic projections, the image size is independent of image location.

This product is similar to the ERS-1 SSG product. Here, however, the geometric accuracy (both absolute and relative) is considerably better because GCPs are used when the data is geocoded. It is also possible to improve the geometric accuracy of SPG products by performing elevation correction. This is done using DTMs which are input from CCT during product generation.

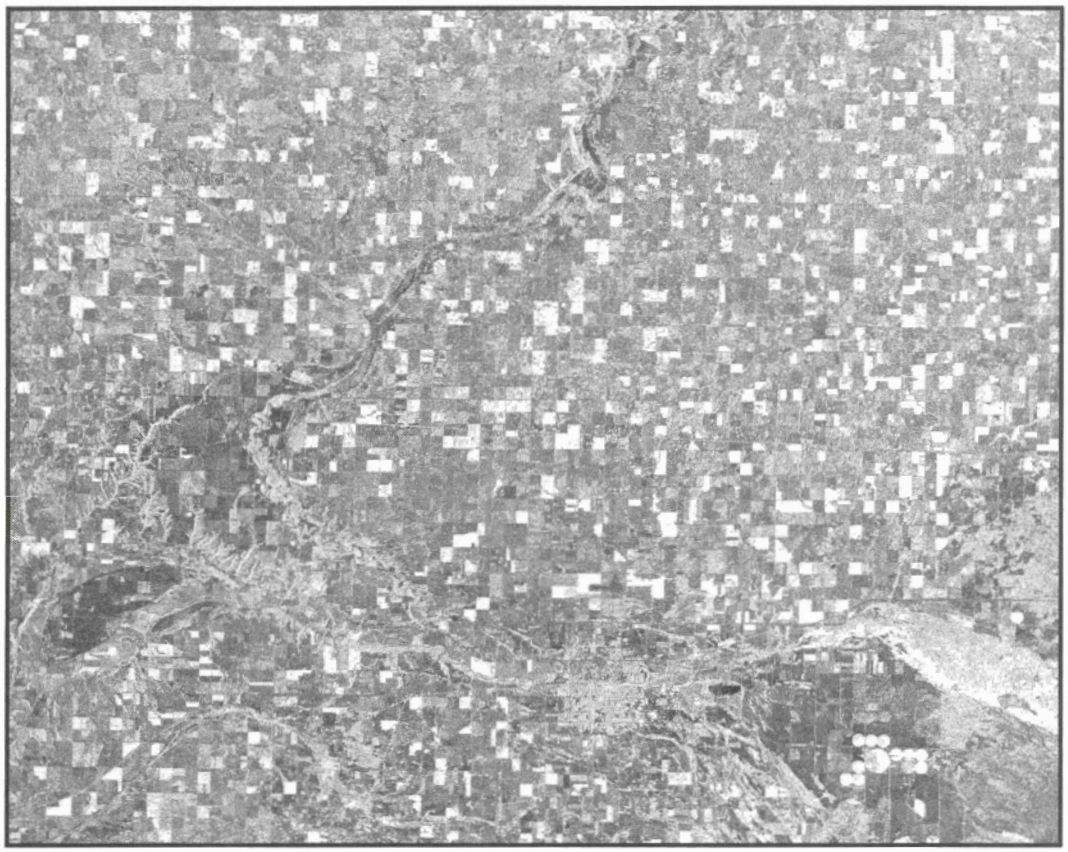


Figure 6-4 Precision Geocoded (SPG) product.

Table 6- 4 ERS-1 SPG Product Parameters

Parameter	Value
map projections	UTM, Lambert Conformal, Polar stereographic
number of lines	UTM (nominal): 4432 UTM (maximum): 4480 Lambert conformal: 4000 or 1600 Polar stereographic : 8000
number of pixels	UTM (nominal): 6224 UTM (maximum): 6720 Lambert conformal: 4000 or 1600 Polar stereographic : 8000
spatial resolution	nominal 35m by 35 m
absolute geometric accuracy (flat terrain)	35 m
relative geometric accuracy (flat terrain)	35 m
number of processed looks	6
type of pixels	8-bit detected
pixel spacing	12.5 m by 12.5 m
distribution media	CCT,ITN

Table 6-4 gives the values of key product parameters for the ERS-1 SPG product.

ERS-1 SAR SINGLE-LOOK COMPLEX PRODUCT

The ERS-1 SLC product is high-resolution, processed single-look SAR imagery from the ERS-1 satellite. The data has not been detected, but rather has been left in its complex form. Georeferencing of the image is achieved through latitude and longitude information embedded in each line of image data.

Table 6-5 ERS-1 SLC Product Parameters

Parameter	Value
coordinate system	zero Doppler, ground range or zero Doppler slant range
number of lines	ground range:16,000 slant range :25,000
number of pixels	ground range:13,920 slant range : 4,912
spatial resolution	7m in azimuth by ground range: 35 m or slant range :13m
absolute geometric accuracy (flat terrain)	1100m
relative geometric accuracy (flat terrain)	40m
number of processed looks	1
type of pixels	16-bit I, 16-bit Q
pixel spacing	ground range: 6.25 m by 6.25 m slant range: raw data sample spacing
distribution media	CCT,ITN

Table 6-5 gives the values of key product parameters for the ERS-1 SLC product.

ERS-1 SAR SINGLE-LOOK DETECTED PRODUCT

The ERS-1 SLD product is a detected version of the ERS-1 SLC product. As such, it consists of high-resolution, processed single-look SAR imagery from the ERS-1 satellite. Georeferencing of the image is achieved through latitude and longitude information embedded in each line of image data.

Table 6-6 ERS-1 SLD Product Parameters

Parameter	Value
coordinate system	zero Doppler, ground range or zero Doppler, slant range
number of lines	ground range: 32,000 slant range : 25,000
number of pixels	ground range: 13,920 slant range : 4,912
spatial resolution	7m in azimuth by ground range: 35 m or slant range :13m
absolute geometric accuracy (flat terrain)	1,100m
relative geometric accuracy (flat terrain)	40m
number of processed looks	1
type of pixels	16-bit detected
pixel spacing	ground range: 3.125 m by 3.125 m slant range: raw data sample spacing
distribution media	CCT,ITN

Table 6-6 gives the values of key product parameters for the ERS-1 SLD product. *

*This image was not produced due to the large number of lines and pixels.

Figure 6-5 Multi-Look Detected (MLD) product.

ERS-1 SAR MULTI-LOOK DETECTED PRODUCT

The ERS-1 MLD product is a multi-look version of the ERS-1 SLD product. As such, it consists of high-resolution, processed SAR imagery from the ERS-1 satellite. Georeferencing of the image is achieved through latitude and longitude information embedded in each line of image data.

In terms of how the data is processed by the SAR processor, the ERS-1 MLD product is very similar to the ERS-1 SGF product. They differ, however, in the coordinate systems used for the image data.

Table 6-7 ERS-1 MLD Product Parameters

Parameter	Value
coordinate system	zero Doppler, ground range or zero Doppler, slant range
number of lines	ground range: 8,000 slant range : 6,250
number of pixels	ground range: 8,000 slant range : 4,912
spatial resolution	30m in azimuth by ground: 35 m, or slant range :13m
absolute geometric accuracy (flat terrain)	1,100m
relative geometric accuracy (flat terrain)	40m
number of processed looks	6
type of pixels	16-bit detected
pixel spacing	ground range: 12.5 m by 12.5 m slant range: raw data sample spacing
distribution media	CCT,ITN

Table 6-7 gives the values of key product parameters for the ERS-1 MLD product.

ERS-1 SAR RAW PRODUCT

The ERS-1 RAW product consists of unprocessed, complex ERS-1 data.

Table 6-8 ERS-1 RAW Product Parameters

Parameter	Value
number of lines	30,000
number of pixels	5616
type of pixels	(8-bit I, 8-bit Q)
distribution media	CCT

Table 6-8 gives the values of key product parameters for the ERS-1 RAW product.

6.2 Information and orders

For information and price lists or to place an order:

Canadian government users please contact:

ERS-1 Order Desk
Hunt Club Road
Ottawa, Ontario
Tel: 613-990-8033
FAX: 613-991-5038

All other North American users:

Radarsat International
1203-275 Slater Street
Ottawa, Ontario
Tel: 613-238-6413
FAX: 613-238-5425

Orders must be submitted in writing. Order forms are available from CCRS or RSI. If any details are missing, you may be contacted by telephone.

Orders may be of two types, one-time or standing. A one-time order is a request for a particular product from data acquired over a given area within a certain time window. One-time orders will be satisfied from archive if possible.

A standing order requests repetitive coverage of a given area, usually for monitoring purposes. Standing orders are only accepted from agencies who have signed an agreement with CCRS.

Copies of the ERS-1 CCT Product Format Specifications (R3) may be obtained from the CCRS Order Desk or from RSI.

6.3 Ordering other ERS-1 Products

Users wishing to access the Low Bit Rate (LBR) Fast Delivery products from the AES operational distribution network should first contact the CCRS Order Desk (613-990-8033) who will advise on the applicable ESA policies and restrictions, and, if these are met, will notify ESA of the proposed use of data.

For details of the AES operational distribution network, users should contact:

Chief, Development Division
Canadian Meteorological Centre
2121 North Service Road
Trans Canada Highway
Dorval, Quebec
H9P 1J3

All other ERS-1 Products, ie.: SAR image mode data from areas outside of the Canadian coverage area, AMI WAVE mode, AMI WIND mode, radar altimeter and ATSR data products must be requested from ESA's Earthnet Office.

ESA Earthnet
ERS-1 Order Desk
ESRIN
via Galileo Galilei
Casella Postale 64
00044 Frascati, Italy
Tel: 39-6-941801
Fax: 39-6-94180-361

ESA intends to install an on-line ordering system which users will be able to call directly. ESA will relay requests for off-line products to one of the four national PAFs, each of which will specialize in particular products and maintain specialized archives as described previously.

References

R1) ERS-1 Ground Stations Product Specification ER-IS-EPO-GS-0201 - Issue 1, Rev. 0.

R2) CEOS SAR Data Products Format Standard. Appendix A, CEOS Working Group on Data Revision 2.0, March 10, 1989.

R3) Canadian ERS-1 CCT Product Format Specification CE-IS-MDA-SY-0200.