RADARSAT Technical Specifications

Orbit:	Sun synchronous	
	Altitude	1000 km
	Period	105.2 minutes
	Inclination	99.5°
	Ascending node	21:44 local time
	Repeat cycle	16-day
Life:	Five years, extended to 10 with in-flight servicing	
Launch:	1990	

Synthetic Aperture Radar

SAR Coverage	Northern Canada once every 24 hours Canada south of latitude 71.5° N once every 72 hours
Frequency	5.3 GHz
Swath width	130 km nominal
Accessibility swath	500 km
Angle of incidence	20° to 45°
Resolution	28 metres

Scatterometer

Spatial resolution	25 km
Wind speed accuracy	3 to 20 m/s winds: ±2 m/s 20 to 30 m/s winds: ±10 per cent of the wind speed
Wind direction accuracy	Within 20° rms
Swath	600 km, from 210 km to 810 km on each side

Multispectral Scanners (MSS)

1. Multilinear Array Sensor

Swath	417 km
Extreme Incidence Angle	±30°
Resolution	30 metres
Spectral Bands	1. 0.45 - 0.50 micrometre 2. 0.52 - 0.59 micrometre 3. 0.62 - 0.68 micrometre 4. 0.84 - 0.88 micrometre

2. Advanced Very High Resolution Radiometer (AVHRR)

Swath	3000 km (fixed on ground track)
Resolution	1300 metres
Spectral Bands Visible	0.580 - 0.68 micrometre 0.725 - 1.10 micrometres
Infrared	3.550 - 3.93 micrometres 10.300 - 11.30 micrometres 11.500 - 12.50 micrometres

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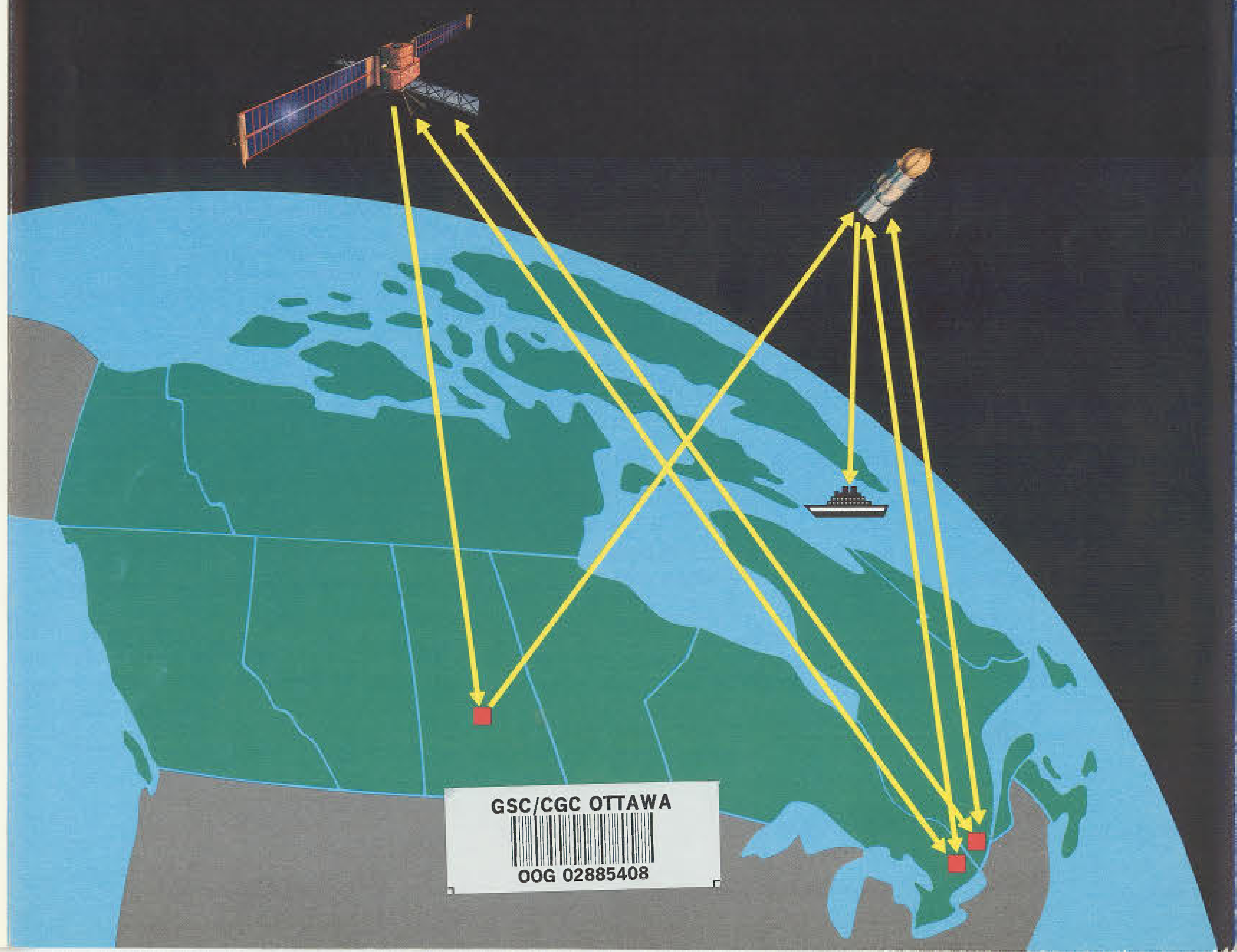
Mission Description

RADARSAT, Canada's first remote sensing satellite, will have a high-resolution steerable synthetic aperture radar (SAR) that can penetrate cloud and darkness. SAR, together with three other sensors, will provide data for imagery that will greatly aid resource management, as well as provide ice information for Arctic navigation and offshore drilling rigs.

RADARSAT will have down-link options. When it is beyond the range of Earth-based receiving stations, it can tape data being collected by its sensors and transmit them when within range of the receiving antennas.

Sea ice and iceberg conditions detected by SAR will be transmitted from RADARSAT to Mission Control at Ottawa. There the Ice Information Centre will process the data and relay the information via communications satellite to ships in Arctic waters and to drilling rigs off the East Coast.



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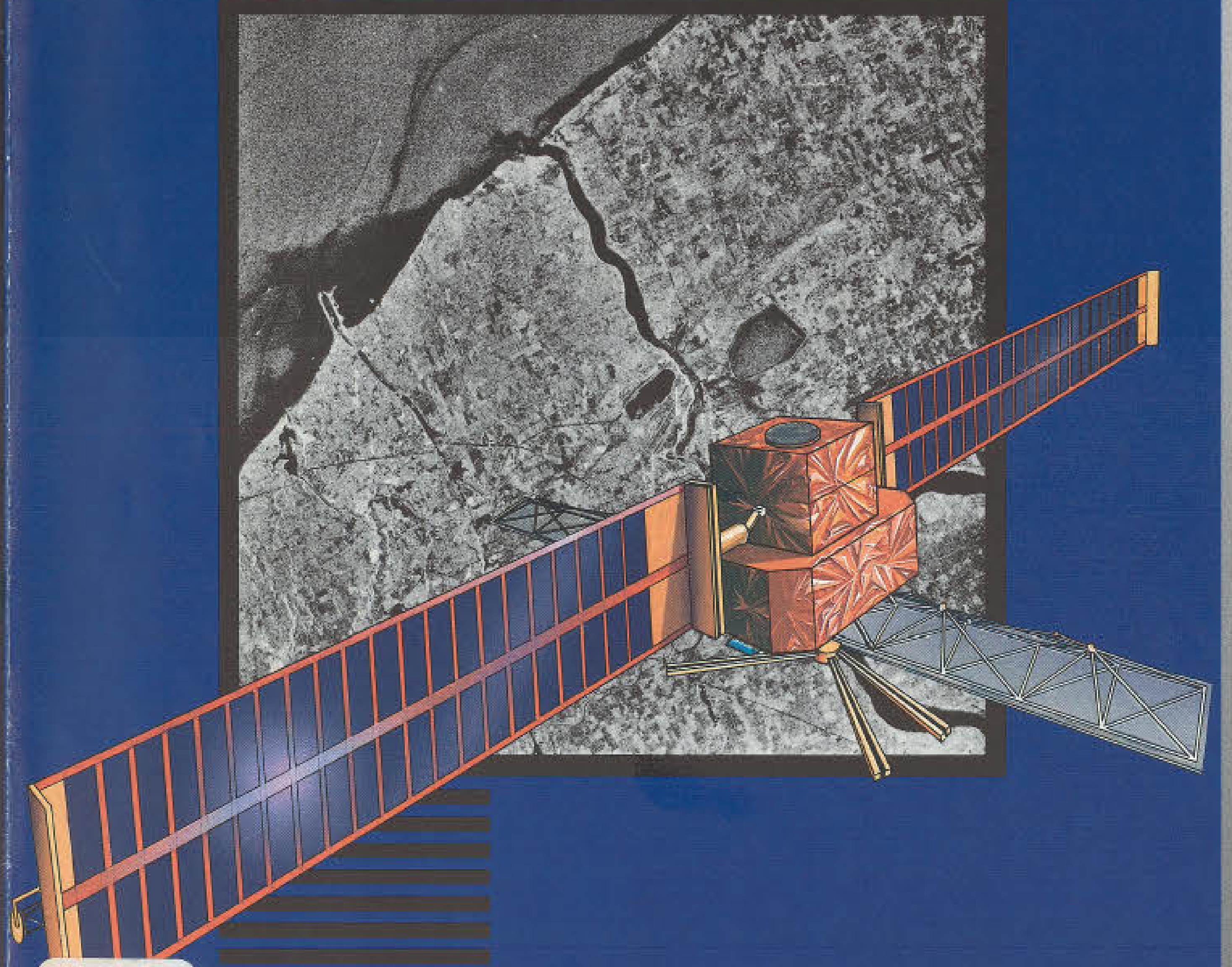


Canada

RADARSAT, Canada's first remote sensing satellite, will be placed in a near-polar orbit early in the next decade. It will provide a unique surveillance service for resource management and other purposes.

The RADARSAT program was initiated in 1981 through the Canada Centre for Remote Sensing (CCRS), a branch of the Department of Energy, Mines and Resources. The Department of Communications, with its extensive experience in space technology, is the major technical partner with the responsibility for managing space contracts in the private sector. The departments of Environment, Agriculture, Transport, and Fisheries and Oceans are also participants in the program, now in its second phase, the detailed technical design phase.

The satellite will perform a variety of roles, serving customers interested in agriculture, energy and hydrology, as well as those concerned with ice-covered waters, iceberg movement, ocean surface information and nonrenewable resource production. It will also enable Canada to sell remotely sensed data and expand its sales of data processing facilities on the international market.

The Instruments

The principal instrument will be a synthetic aperture radar (SAR), which produces high-resolution images by using a technique that makes a small spaceborne antenna perform like a very large one. The other instruments will include two optical multispectral scanners and a scatterometer.

SAR is an active sensor that transmits and receives a signal that penetrates cloud and darkness. It will scan the surface to the left of RADARSAT with a swath of about 130 km. Its unique quality will permit the antenna beam to be steered electronically through a 20 degree to 45 degree angle of incidence over a 500 km track swath.

SAR's sensitivity to moisture content of vegetation and soil will provide crop assessments in Canada and around the world. It will also yield valuable geological information for mineral and petroleum exploration, as well as basic research. SAR will also furnish data for the first stereogeological map of the world.

The instrument will discriminate first-year ice from heavier multiyear ice to identify navigable Arctic sea routes, and will provide information for offshore drill rigs on iceberg movement and speed. The RADARSAT system will transmit sea ice forecasts to ships and drill rigs via a communications satellite.

The delineation of ice cover and its extent is also of interest for determining the heat flow from the oceans to the atmosphere, a key variable in modelling world climate.

The *scatterometer* is also an active radar instrument — a microwave sensor that measures wind speed and direction over ocean surface. It will have two beams, each covering a 600 km swath on each side of the satellite.

The scatterometer's very wide swath — totalling 1200 km — provides vital meteorological information that can be amassed over 90 per cent of Earth's oceans at least once in every two-day period. The instrument will have its own data storage system from which data can be replayed from any ocean within two hours of detection.

The *optical instruments* are multispectral passive sensors, which gather reflected energy from the surface. One is a *multilinear array sensor*, which will generate imagery in any of four spectral bands covering a 400 km swath.

The other passive instrument proposed is an *advanced very high resolution radiometer (AVHRR)*, employed mainly to monitor soil moisture and crop conditions. This is a multispectral scanner operating in five bands: two in the visible, and three in the infrared bands. The AVHRR has a swath of 3000 km and a ground resolution of 1300 m.

These instruments and SAR can be used in concert to produce combined data on agricultural and hydrological resources.

State-of-the-art tape recorders on board will store RADARSAT data, permitting worldwide information to be obtained without the need for remote ground stations.

In-Orbit Servicing

Planned originally for a five-year life, RADARSAT is now to have longevity built into it. NASA astronauts have repeatedly demonstrated that they can capture satellites in need of repair or fuel, and return the satellites to orbit. Plans for RADARSAT have been amended to build in a capability to move it, if needed, from its 1000 km working orbit to the 240 km space shuttle level. There it can be refuelled, undergo repairs, or have instruments upgraded before being redeployed back to its working track. This modification will more than double its value to users by extending its life to 10 years.

International Participation

Although SAR is Canadian designed, and will be constructed through contracts to Canadian space industries, RADARSAT will benefit from international participation. The U.S. National Oceanic and Atmospheric Administration will provide the scatterometer and the AVHRR optical instrument. The multilinear array sensor will be purchased from the Federal Republic of Germany. The United Kingdom will build the body of the satellite. The satellite will be assembled and tested at the David Florida Laboratory near Ottawa. NASA will provide RADARSAT's 1990 launch from a shuttle.

In service, the satellite will be controlled from the Mission Control Centre in Ottawa. The data acquisition, processing and distribution service will also be located in Ottawa. The main ground receiving station will be in Gatineau, Quebec, just north of Ottawa. An important component of the ground complex is the Ice Information Centre at Ottawa, which will ensure that critical imagery of Arctic and coastal ice is processed, analyzed and retransmitted to users within three hours of its detection.

Through international agreements, three data-receiving stations are already being planned. NASA will operate a station at Fairbanks, Alaska; a U.K. station will be located at Stranraer, Scotland; and Brazil will have a station at Cuiabá. More are expected to follow.

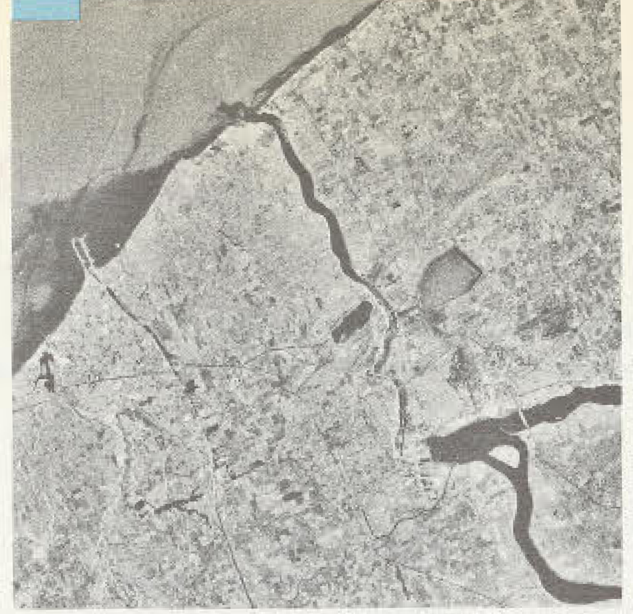
Economic Benefits

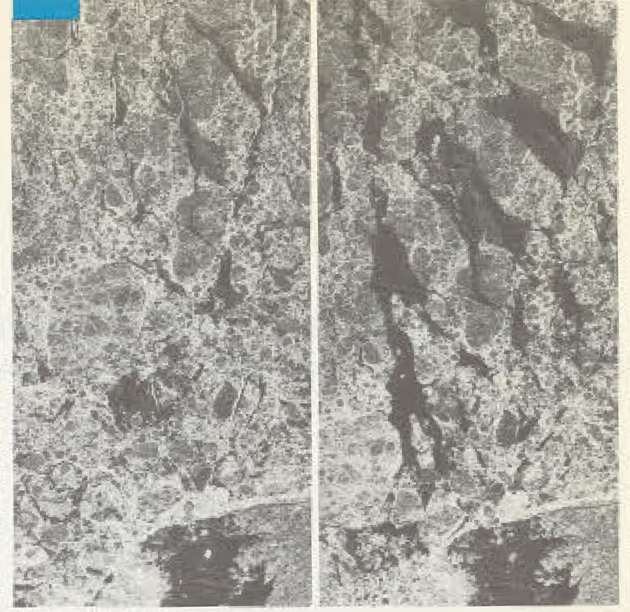
It is conservatively estimated that the benefits to Canada from the use of RADARSAT data — for ice forecasting, iceberg and ship location, domestic and world crop monitoring, geological exploration, and data sales — will total about $150 million annually. Sales of space and ground systems and related services are estimated at $280 million to $550 million over the period 1985 to 1995.

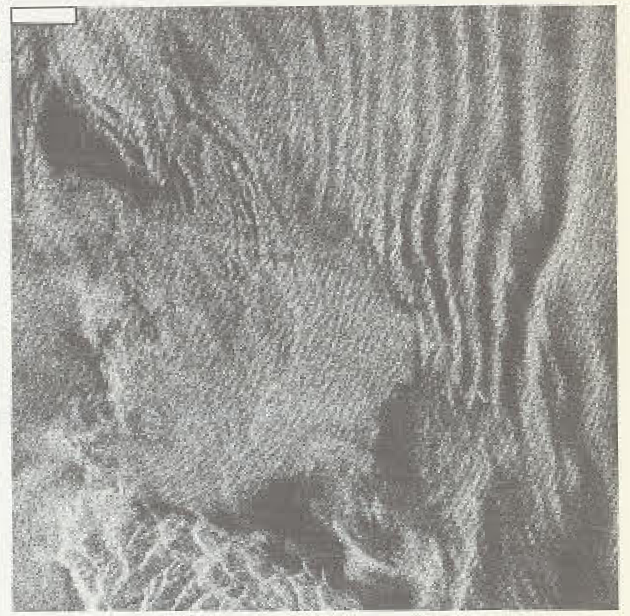
Many of the benefits and sales depend on the timing of Arctic and East Coast offshore petroleum developments, on inclusion of in-orbit servicing and on the timing of the RADARSAT program.

The cost of the program is $520 million, with Canada providing $300 million, and the United Kingdom, the United States and other international partners contributing the equivalent of $220 million. The inclusion of in-orbit servicing adds some $40 million to the cost of RADARSAT, which will be more than offset by the satellite's increased economic benefits.

Based on the estimated costs and benefits, the present net value for a five-year program without servicing is about $250 million. For the 10-year program including servicing the net value is about $750 million. Estimates suggest that the program will create 8000 direct and 12 800 indirect person-years of employment in the remote sensing services and in high-technology industries.







Land — Agriculture

In this 1978 SEASAT image centred on the Niagara River, the rough water of the rapids above and below the falls appears grey-white. The smooth water on either side is black. A similar difference in wave activity appears in Lake Ontario. The entry of the Welland Canal and the canal itself are readily apparent. Ships in Lake Ontario appear as white dots.

The ability of such imagery to identify crop types and soil moisture, and to forecast yields, provides significant benefits to the agricultural community.

Ice

These two SEASAT SAR images show pack ice in the Beaufort Sea west of Banks Island on October 3 and 6, 1978. At this time of year, almost all the sea ice in the imagery is old ice that contains newly ice-covered leads, the black, linear features on the imagery. On the two images, ice motion can be observed from the displacement of ice features relative to the coast of Banks Island. This motion helps define the velocity field within the ice and can be used to forecast ice conditions. The famous ice island T-3 appears on both images, and has a bright surface pattern. This ice island was a section of the Ellesmere ice shelf, and its motions have been tracked in the Arctic Ocean for more than 40 years. Plots of ice island motions have helped define the nature of oceanic currents in the Arctic Ocean and the Greenland Sea.

Knowledge of the position and movement of such ice types is needed daily for safe and efficient operation of drill rigs, icebreakers and oil tankers. RADARSAT's SAR will cover the entire Arctic region at least once a day, regardless of weather or darkness; within a few hours of the satellite's passage overhead, the processed SAR image will be transmitted to the bridge of a rig or ship.

Land — Geology

This view of the glaciers and mountains surrounding Mount McKinley in Alaska was obtained by the SEASAT SAR on July 23, 1978. SAR yields greater detail and delineation of many geological features than can be seen with airborne or LANDSAT imagery.

RADARSAT's SAR will also be able to image the terrain from various angles and thus produce stereographic three-dimensional imagery, providing still more information to aid the geologist's analysis.

Oceans

This SEASAT SAR image, taken on August 13, 1978, shows interesting refraction patterns of surface waves in an inlet of Vancouver Island at Tofino, B.C. The wave crests are refracting around the land because the wavelength decreases when it meets the shallow nearshore waters. The black region represents the smooth, protected waters in the lee of the island. The larger linear bands seen on the right-hand side of the image are near-surface internal waves generated by the flood tide at the entrance to the inlet.

The ability of radar to distinguish between many ocean surface characteristics and to image them reliably despite cloud cover or darkness equips the oceanographer with a powerful new research tool. The SAR ocean data combine effectively with the wide-swath scatterometer wind data to give early warning of severe ocean storms that could threaten east coast drill rigs and shipping.