

**RADARSAT-2 Science and Operational
Applications Research (SOAR)**

**Specific Request for
SOAR Proposal
Canadian Provinces and Territories
Initiative (SOAR-CPT)**

[Request for Proposal]

September 2009

Canadian Space Agency

In collaboration with

**MacDonald Dettwiler and Associates Ltd. -
Geospatial Services Inc.**

Canada Centre for Remote Sensing

Program Description

RADARSAT-2 Science and Operational Applications Research (SOAR)

Table of Contents

1.	<i>Description of the SOAR Program</i>	1
1.1.	Background.....	1
1.2.	The SOAR Mission.....	1
1.3.	SOAR Program Application Sectors.....	1
1.4.	SOAR Program Objectives	2
1.5.	Program Schedule	3
2.	<i>Program Roles, Relations and Obligations</i>	3
2.1.	Sponsors.....	3
2.2.	Proposers.....	4
2.3.	SOAR Coordination Office	4
3.	<i>Instructions Related to the Levels of Maturity of an Application</i>	5
3.1.	Improvements and Sustainability to Current Operational Applications.....	5
3.1.1.	Objectives	5
3.1.2.	Eligibility	5
3.1.3.	Evaluation Criteria.....	5
3.2.	New Applications.....	6
3.2.1.	Objectives	6
3.2.2.	Eligibility	6
3.2.3.	Evaluation Criteria	6
3.3.	Research and Development.....	6
3.3.1.	Objectives	6
3.3.2.	Eligibility	7
3.3.3.	Evaluation Criteria.....	7
4.	<i>Program Limitations</i>	7
4.1.	Program Termination	7
4.2.	Award.....	7
4.3.	Data Suitability	8
4.4.	Data Quantities	8
4.5.	Data Access	8
4.6.	Data Award and Service Levels	8
4.7.	Promotion of Project Results.....	9
4.8.	Option to Withdraw from the Program.....	9
4.9.	Intellectual Property	9

5.	<i>Selection and Implementation of Projects</i>	9
5.1.	Selection Procedures	9
5.2.	Implementation of Successful Proposals	10
6.	<i>Application Process and Guidelines for the Preparation of Proposals</i>	10
6.1.	General Guidelines	10
6.2.	Proposal Content and Structure Requirements.....	11
	<i>Appendix A: Overview of the RADARSAT-2 System</i>	1

Acronyms:

CCRS: Canada Centre for Remote Sensing, Natural Resources Canada

CSA: Canadian Space Agency

MDA: MacDonald, Dettwiler and Associates Ltd

MDA GSI: MDA Geospatial Services Inc.

R&D: Research and Development

SAR: Synthetic Aperture Radar

SOAR: Science and Operational Applications Research

1. Description of the SOAR Program

1.1. Background

The SOAR research and development (R&D) program is a partnership program between MDA GSI and the Government of Canada as represented by the Canadian Space Agency (CSA) and the Canada Centre for Remote Sensing (CCRS). With the launch of the RADARSAT-2 satellite, Earth observation by satellite entered a new era bringing to prominence the advantages of synthetic aperture radar (SAR) sensors and offering new opportunities for the public sector, industry and academia. RADARSAT-2 is equipped with a full range of new capabilities: high-resolution mode (1 metre spatial resolution), Standard and Fine resolutions with fully polarimetric capabilities (Quad-Pol) and dual polarizations for RADARSAT-1 heritage modes. The SOAR program offers the possibility of exploring the enhanced capabilities of RADARSAT-2 and capitalizing on them by using them in certain applications, meeting operational requirements or contributing to new commercial opportunities.

Quad-Pol mode provides four channels of data (HH, HV, VH, VV). Dual polarization mode is either HH + HV or VV + VH. Note that phase data in Single Look Complex (SLC) format is available with restrictions, for all RADARSAT-2 modes except the SCANSAR modes. A more detailed description of the RADARSAT-2 operating modes can be found in Appendix A.

The SOAR-CPT initiative is intended for **Canadian provincial and territorial governments** (proposer). In the proposal, the principal investigator and his or her team must demonstrate that the proposed project is commensurate with one or more of the SOAR Program Objectives as described in Section 1.4.

1.2. The SOAR Mission

"Making the scientifically possible operationally practical."

The intent of the SOAR program is to build on the successes of RADARSAT-1 by developing methods and information products to address the needs of the application sectors using the new capabilities of RADARSAT-2.

1.3. SOAR Program Application Sectors

The SOAR program emphasizes the strengths of RADARSAT-2. Table 1 lists the application sectors in which RADARSAT-2 is expected to improve information content. One of the goals of the SOAR program is to shed light on how to use the new RADARSAT-2 capabilities in these and other key sectors. The program focuses on basic and applied R&D on algorithms, methods and applications. An application is expected to be at the development, feasibility, demonstration, pilot project or pre-operational level of maturity. **The SOAR program does not provide support for operational or commercial activities**, for which data must be purchased from MDA GSI.

Table 1: Potential Contribution of RADARSAT-2 to Existing Applications

Application	Activity Sector	Resolution	Dual Polarization	Quad Polarization
Marine surveillance	Ship detection			
	Marine pollution			
	Ocean features			
Defence	Marine surveillance			
	Earth surveillance			
	Topographic mapping			
Mapping	Commercial intelligence			
	Land use & land change			
	Telecommunications			
	Digital elevation model			
Geology	Shoreline mapping			
	Off-shore exploration (oil & gas and minerals)			
	Onshore exploration (oil & gas)			
Forestry	Land use & land change			
	Road detection			
	Mapping of burned areas			
Agriculture	Compliance monitoring			
	Crop monitoring			
	Soil moisture			
Disaster management	Floods			
	Oil pollution			
	Damage assessment			
Ice mapping	Ice maps and types			
Hydrology	Mapping of snow water equivalence			
	Mapping of wetlands			

* Table adapted from: Van der Sanden, J.J. (2004). Anticipated applications potential of RADARSAT-2 data, Canadian Journal of Remote Sensing, Vol. 30 No. 3, pp. 369-379.

Significant improvement
Some improvement
No change

1.4. SOAR Program Objectives

The RADARSAT-2 program is a public-private partnership. It builds on the strengths of this type of partnership to respond to the environmental, commercial and security requirements of today's world. The main objective of the SOAR

program is to explore, at the R&D level, viable solutions to current problems and issues. The intent of the SOAR program is to develop practical applications and tools that make use of the new capabilities of RADARSAT-2. Projects that address these issues and, if possible, validate results with end-users will be considered worthy of support.

SOAR Sponsors will loan limited amounts of RADARSAT-2 data to selected proposers to further the utilization of the new RADARSAT-2 capabilities.

The SOAR-CPT initiative, under the umbrella of the SOAR program, is aimed at three levels of maturity with respect to applications:

A) *Improvements and sustainability added to current operational applications*

Particular emphasis is put on exploring the advanced capabilities of RADARSAT-2 and their potential to improve existing operational applications using a satellite-borne synthetic aperture radar (SAR) sensor and/or make them sustainable.

B) *New applications*

Efforts are devoted to researching and defining new pre-operational opportunities that could be exploited by the improved RADARSAT-2 capabilities.

C) *Research and development*

The aim is to process and characterize (information retrieval) the data obtained using the new RADARSAT-2 modes.

1.5. Program Schedule

The SOAR-CPT initiative is expected to continue throughout the lifetime of the RADARSAT-2 satellite, estimated at seven years. The satellite was successfully launched in December 2007 and has been in operation since April 2008. The evaluation period is planned for four to six weeks following the date of submission of a proposal entry. There is no closing date for the submission of proposals.

2. Program Roles, Relations and Obligations

The SOAR-CPT initiative is a partnership between the Sponsors (CSA and CCRS), MDA GSI, the Proposers and the SOAR Coordination Office (CSA). The roles and responsibilities of these various entities are described in the following sections. Note that MDA GSI operates and owns the RADARSAT-2 satellite, has a right to view the proposals and the projects that are supported in order to ensure that they are not of a commercial nature, and will treat all information received in confidence.

2.1. Sponsors

With the assistance of the SOAR Coordination Office, the Sponsors are responsible for the following with respect to approved projects:

- ◆ lending processed RADARSAT-2 scenes in geotiff format, preferably via a dedicated FTP site. The data will be programmed and processed through basic planning and regular processing services. Data will be delivered in **Single Look Complex or georeferenced (Path Image)** format;
- ◆ providing limited technical support for reading RADARSAT-2 products supplied under the SOAR-CPT initiative;
- ◆ coordinating communications activities (workshops, symposiums, etc.);
- ◆ publishing communication material of interest (symposium proceedings, promotional material, etc.).

In addition, the Sponsors will:

- ◆ treat all information provided in proposals in confidence;
- ◆ review advance copies of papers or communications prepared and submitted by Proposers.

2.2. Proposers

The Proposers shall:

- ◆ agree to have their proposal evaluated by the Sponsors and by experts in the field, and to allow MDA GSI to be aware of it;
- ◆ submit a proposal for a non-operational, non-commercial project;
- ◆ sign an agreement with the Sponsor or Sponsors and MDA GSI concerning the lending of data for research purposes;
- ◆ provide a project timeline and milestone dates;
- ◆ coordinate the project execution;
- ◆ ensure their project has sufficient funding and resources to complete the planned research within the approved timeframe;
- ◆ publish the results of the research project and appropriately acknowledge the SOAR-CPT initiative;
- ◆ provide the Sponsors with advance copies of their publications and communications;
- ◆ submit to the Sponsors, on request, the results and methods used for promotional purposes;
- ◆ attend a SOAR workshop or symposium to present results;
- ◆ return the data and products loaned following completion of the project.

2.3. SOAR Coordination Office

The SOAR Coordination Office shall:

- provide Proposers with information on the program and related initiative guidelines during the period for filing proposals and preparing communication activities;
- provide liaison between the Proposers and the Sponsors;
- provide administrative support for the program, specifically by coordinating the data acquisition and delivery services provided by the Sponsors;
- liaise Proposers with other scientists, partners or stakeholders working in a similar research area.

3. Instructions Related to the Levels of Maturity of an Application

The SOAR-CPT initiative is aimed at three distinct levels of maturity, each based on a specific development phase, but focuses on the sustainability and improvement of a current application that uses SAR sensors (section 3.1) or the development of a new application (section 3.2) in the context of a specific need. The following are the general instructions for submitting a proposal.

3.1. Improvements and Sustainability added to Current Operational Applications

3.1.1. Objectives

Improve current SAR operational applications or make them sustainable using the new capabilities of RADARSAT-2.

3.1.2. Eligibility

This level of maturity targets government agencies or departments that currently use SAR data to meet certain operational requirements (e.g., users). Its purpose is to provide a means to test the new capabilities of the RADARSAT-2 satellite in the framework of current operating requirements, but also future operational needs.

Proposers (e.g., operational users of RADARSAT-1) could sub-contract work to complete their projects and to examine and validate the usefulness of the capabilities of the new RADARSAT-2 satellite.

3.1.3. Evaluation Criteria

The proposals should demonstrate the following:

- ◆ current use of SAR data to meet an operational requirement;
- ◆ the technical merit of the proposed idea – how a new capability of RADARSAT-2 can improve/sustain current operations and services;

- ◆ that the project team has the required capability and determination to achieve the objectives of the project;
- ◆ a valid work plan to test the new capabilities and make the necessary modifications to a product or the application;
- ◆ sufficient finances and resources available for completing tests during the period covered by the SOAR-CPT initiative;
- ◆ willingness to publish project results.

3.2. New Applications

3.2.1. Objectives

Develop new products and services or innovative applications that make use of the new capabilities of RADARSAT-2.

3.2.2. Eligibility

This level of maturity primarily targets government agencies or departments that have a functional need that the improvements offered by the RADARSAT-2 satellite would address. This level is focused on the development of innovative solutions.

3.2.3. Evaluation Criteria

The proposals should demonstrate the following:

- ◆ the target application(s) for the new service or product;
- ◆ active participation in the project by an agency or department of the CPT government interested in the service or product to be developed;
- ◆ the improvements or technological advantages that the new capabilities of RADARSAT-2 can add to the service or product;
- ◆ a valid work plan for developing the product or service, indicating how the product or service will be tested;
- ◆ sufficient finances and resources available to complete the project during the period covered by the SOAR-CPT initiative;
- ◆ willingness to publish project results.

3.3. Research and Development

3.3.1. Objectives

To characterize the data obtained using the new RADARSAT-2 modes and, where possible, to identify new applications that may utilize the products.

3.3.2. Eligibility

This level of maturity targets government agencies and/or departments involved in basic and applied research activities. Its purpose is to advance the development of algorithms, methodologies or products for existing or potential applications.

3.3.3. Evaluation Criteria

The proposals should demonstrate the following:

- ◆ an understanding of SAR and the potential offered by RADARSAT-2 to deliver a technological advantage to the product or application;
- ◆ the potential benefits of the project to support future operational activities;
- ◆ a work plan indicating how the potential use of the information will be tested;
- ◆ sufficient finances and resources available to complete the R&D project;
- ◆ willingness to publish project results.

4. Program Limitations

4.1. Program Termination

The Sponsors reserve the right to cancel all or part of the program at any time, without any liability whatsoever. Events such as the failure of the satellite or cancellation of supporting funds could force termination of the program.

Under no circumstances will the Sponsors, MDA and MDA GSI be liable for any consequential, indirect, special, punitive, or incidental damages or lost profits, whether foreseeable or unforeseeable, based on the Canadian Legislation or based on claims of Proposers, their partners and/or end-users (including, but not limited to, claims for loss of data, goodwill, use of money or use of the product, interruption in use or availability of data, stoppage of other work or impairment of other assets), arising out of breach of express or implied warranty or remedy, breach of contract, misrepresentation, negligence, strict liability in tort or otherwise, regardless of whether a limited remedy is deemed to fail its essential purpose.

4.2. Award

The SOAR-CPT initiative will loan products from the RADARSAT-2 system to projects that are selected. Submission of a proposal does not guarantee its acceptance.

4.3. Data Suitability

The Sponsors, MDA and MDA GSI do not warrant the suitability of the RADARSAT-2 data for any specific application. The Sponsors do not warrant that (i) the RADARSAT-2 data and products will meet the Proposer's or its partners' or end-users' requirements, (ii) the data and products will operate in combinations selected for use by the Proposer's or its partners or end-users, or (iii) use of the data and products will be uninterrupted or error free. The Sponsors, MDA and MDA GSI provide RADARSAT-2 data and products "as-is," without warranty of any kind. All warranties, conditions, representations, indemnities and guarantees with respect to the data and product, whether express or implied, arising by law, custom, prior oral or written statements by the Sponsors, MDA or MDA GSI or otherwise (including, but not limited to, any warranty of merchantability, satisfactory quality, fitness for particular purpose and non-infringement) are hereby overridden, excluded, and disclaimed.

The Proposers must inform themselves of SAR imaging capabilities and limitations as well as applicability for their specific projects.

4.4. Data Quantities

Proposers should note that, although no specific limit has been set on the quantity of data provided, the Sponsors are interested in supporting as many high-quality projects as possible within a given budget allowance. Most of the SOAR-CPT projects are in the R&D or applications demonstration phase and should therefore require a limited number of scenes to demonstrate capabilities. For this reason, all proposals must include an estimate of quantities required, with the relationship between data needs and the objectives of the proposal clearly identified. Requests for large quantities of data must be rigorously justified. The scope of SOAR-CPT project activities must be limited to a demonstration or pre-operational capacity. Operational and commercial projects are not supported by the SOAR-CPT initiative.

4.5. Data Access

Because RADARSAT-2 is equipped with Solid State Recorder, the SOAR-CPT initiative can collect data over almost any location on Earth. However, SOAR-CPT emphasizes projects over Canadian territory.

During routine mission operations, operational and commercial data requests will have priority over SOAR-CPT projects. Although not guaranteed, every effort will be made to provide SOAR-CPT data during the period requested.

SOAR-CPT projects are subject to all regulations relating to the Canadian Legislation.

4.6. Data Award and Service Levels

The SOAR-CPT Sponsors will loan RADARSAT-2 products, free of charge, to the projects that are selected. Acquisition planning services will be restricted to regular service. No urgent or emergency planning services will be provided for

SOAR-CPT projects. We should mention that we will only support regular data processing and data delivery.

Calibrated data will be supplied according to the calibration of the mode requested.

4.7. Promotion of Project Results

In accordance with the objectives of the SOAR-CPT initiative, the Sponsors intend to use the results to promote RADARSAT-2 applications. Proposers must agree and commit to report the results of their project in scientific or technical publications and acknowledge the SOAR program appropriately. They also agree to attend a SOAR program workshop or symposium to present their project results and to provide the Sponsors with material for promotional purposes.

4.8. Option to Withdraw from the Program

Where a Proposer whose project was selected is no longer able or willing to complete the work involved in the project or publish its results, the Proposer shall be required to (i) return all related RADARSAT-2 products and documents to the Sponsors or (ii) purchase the scenes at the commercial price. By doing so, the Proposer will have withdrawn from the SOAR program and terminated its obligations under the SOAR-CPT initiative.

4.9. Intellectual Property

Proposers should be aware that intellectual property rights to RADARSAT-2 data, products and derived products reside with MDA . All data sets shall be marked with the following statement:

RADARSAT-2 Data and Product © MacDonald, Dettwiler and Associates Ltd.
200_ (year of acquisition) – All Rights Reserved.

Distribution licensed by MDA GSI for the SOAR program.

The Proposers will hold the intellectual property in and to value-added products, algorithms and methods resulting from the work on the project, and rights will be granted to the Sponsors and MDA GSI to use the results for promotional purposes only.

5. Selection and Implementation of Projects

5.1. Selection Procedures

The Sponsors will work with experts, including SAR applications specialists and scientists, to review the proposals received. The purpose of the review is to evaluate the technical merit of the proposed projects and applications in light of the

objectives of the SOAR-CPT initiative. The feasibility of the data acquisition, the work plans and the technical merit of the ideas will be assessed. If necessary, the operational potential of the anticipated results of the projects will be evaluated.

The SOAR-CPT initiative Sponsors will make the final decision concerning the selection of each project. Selected projects will receive an allocation of RADARSAT-2 data.

5.2. Implementation of Successful Proposals

After receiving notification that their proposal has been selected, the Proposers will be required to sign a loan agreement for data to be used for research purposes. In the agreement they will confirm:

- ◆ their intention to proceed with the project;
- ◆ availability of financing for the project;
- ◆ the team of people who will work on the project, as well as their qualifications;
- ◆ acceptance of the terms and conditions for receiving the data;
- ◆ acceptance of the allocated data quantities and delivery conditions;
- ◆ agreement to publish results;
- ◆ acceptance of the use of the data as per the terms and conditions stipulated in the loan agreement for data to be used for research purposes.

The SOAR Coordination Office will coordinate data acquisition planning services with the selected Proposers.

6. Application Process and Guidelines for the Preparation of Proposals

This section provides guidelines for the preparation of proposals. In order to ensure an equitable comparative analysis of proposals and to assist in their evaluation, proposals should strictly adhere to these guidelines.

Those wishing to submit an application under the SOAR-CPT program must complete a step-by-step process via the Internet

<http://www.asc-csa.gc.ca/eng/programs/soar/default.asp>:

1. register for the SOAR-CPT initiative;
2. submit a complete proposal online using a secured access website.

6.1. General Guidelines

The following general guidelines explain how to submit an application in response to this SOAR-CPT document.

- ◆ Proposals may be submitted in English or in French.
- ◆ The Sponsors may select only a portion of the proposed project, in which case the Proposer will have the opportunity to accept or decline an agreement based on only part of the proposal.
- ◆ The Sponsors may ask a Proposer to revise and re-submit a proposal or may suggest a possible teaming arrangement with other Proposers. In such a case, the Proposer would be given proper notice.
- ◆ RADARSAT-2 data will be provided for only a limited number of proposals, and the quantity of the data is a function of the Sponsors' budgets.
- ◆ All reviewers/evaluators of SOAR-CPT proposals who come from outside the Government of Canada and MDA GSI will sign a non-disclosure agreement to ensure confidentiality of the Proposer's ideas. When protected information is supplied in a proposal, it must be clearly stipulated that the Proposer holds exclusive ownership of that information. The information will be used by the Sponsors solely for purposes of evaluating the proposal.

6.2. Proposal Content and Structure Requirements

Proposals will be submitted online and must be concise. The basic elements to be completed at the beginning of the proposal are as follows: project title, geographical area to be studied, nature of the application and obligation to publish. The following guidelines must be observed.

A) Principal investigator

This section should provide the name, contact information and affiliation of the principal investigator ('Proposer') for the project, who will be the point of contact between the Parties.

B) Secondary investigator(s)

This section should provide the name, contact information and affiliation of any secondary investigator(s). Contact information should be provided for the team members, partners, subcontractors and end-users. The purpose of this information is to confirm the level of interest in and commitment to the project on the part of the individual or organization.

C) Proposed project objectives and application maturity level

This section should provide a concise statement of the technical objectives of the project and explain how the project meets the objectives of the SOAR initiative. The maturity level of the application is also to be included:

- Improvements and sustainability added to current operational applications
- New applications
- Research and Development

D) Current or future use of SAR data

This section describes how the data are/will be integrated into the 'Proposer's ongoing activities.

E) Technological advantage provided by RADARSAT-2 for current or future (potential) operations

This section should explain to what extent the RADARSAT-2 data could provide a competitive advantage to the application or operation being reviewed. It should address competing technologies and explain how the RADARSAT-2 data could provide an advantage over data from other sensors. Even if the goal is long term, a preliminary evaluation of the cost and benefit aspect is expected at the end of the project.

F) SAR team knowledge

This section should provide a succinct presentation of the project team and of the organization of the work described in the methodology proposal.

The members of the project team should be presented along with a description of their expertise and their roles in the achievement of the objectives of the project and the SOAR-CPT initiative.

G) Proposed method and schedule

This section should describe the approach and method to be used to achieve the objectives of the project and the SOAR initiative. It should also list and describe the tasks to be completed, with start and end dates, specifying the dates on which the RADARSAT-2 data must be acquired and delivered.

H) Geographic area of interest

Identify the region(s) of interest (country, province, city or other specific boundaries, where possible) and specify geographic coordinates (Lat/Long).

I) Scenes requested

This section should include a plan specifying the RADARSAT-2 data required for the project.

The section should provide the following information:

- ◆ period of observation;
- ◆ frequency of observation;
- ◆ duration of each period of observation;
- ◆ RADARSAT-2 preferences (see Appendix A for a more detailed description of the options) including:
 - beam mode and angle of incidence;
 - ascending/descending pass;
 - polarization combination, if needed;

- number of images required.
- type of products required (i.e. SLC or Path Image)

If auxiliary data is essential to the success of the project submitted, the proposal should specify an acquisition plan for these data and establish relevance and feasibility.

J) Expected funding source

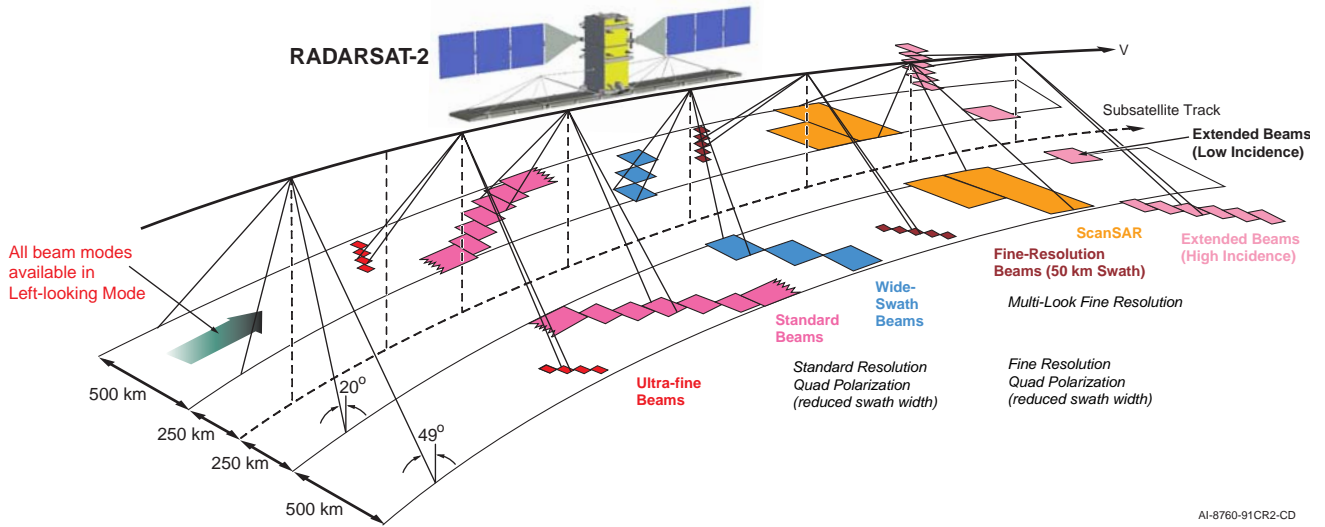
This section should clearly indicate the funding, i.e., the name of the internal project or program overseeing the proposed project. Only Proposers demonstrating the capability to complete the project, as described, will be awarded data. Firm commitments with respect to all resources required to carry out the work associated with the proposal must be provided in writing upon signature of the loan agreement for data to be used for research purposes.

K) Investigator's comments

The investigator may provide additional comments or information to ensure that the proposal is properly understood and facilitate its evaluation.

Appendix A: Overview of the RADARSAT-2 System

A complete presentation of the RADARSAT-2 system can be found at www.radarsat2.info.



AI-8760-91CR2-CD

Legend

All beam modes...	Tous les modes d'exploitation du faisceau sont disponibles en visée à gauche et à droite
Spotlight beams	Faisceau Hyperfin
Ultra-fine beams	Faisceau ultra-fin
Standard beams	Faisceau standard
Wide-swath beams	Faisceau large
Fine resolution beams (50 km swath)	Faisceau fin (fauchée de 50 km)
ScanSAR (narrow or wide)	ScanSAR (étroit ou large)
Extended beams (high incidence)	Faisceau expérimental (incidence élevée)
Extended beams (low incidence)	Faisceau expérimental (faible incidence)
Multi-Look Fine beams	Faisceau fin à Multi-visée
Standard Resolution Quad Pol	Polarisation quadruple à résolution standard
Fine Resolution Quad Pol	Polarisation quadruple à haute résolution
Subsatellite track	Trace

RADARSAT-1 Modes with Selective Polarization	Beam Mode	Nominal Swath Width (km)	Swath Coverage to Left or Right of Ground Track (km)	Approximate Resolution (ground range X azimuth) (m)
Transmit H or V Receive H or V or (H and V)	Standard	100	250-750	25 x 26
	Wide	150	250-650	30 x 26
	Fine	50	400-800	8 x 8
	ScanSAR Wide	500	250-700	100 x 100
	ScanSAR Narrow	300	250-700	50 x 50
Selective Single Polarization				
Transmit H and H on alternate pulses	Low Incidence	170	125-300	40 x 26
	High Incidence	75	750-1050	18 x 26
Polarimetry (Quad-Pol)				
Transmit H and V on alternate pulses Receive H and V on every pulse	Standard QP	25	250-600	25 x 8
	Fine QP	25	250-600	12 x 8
Selective Single Polarization				
Transmit H or V Receive H or V	Multi-look Fine	50	400-800	8 x 8
	Ultra-fine	20	400-800	3 x 3
	Spotlight	18x8	250-800	2 x 1