



Constellation

RADARSAT

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*CEOS SAR 2019 Workshop
VH-RODA Workshop*



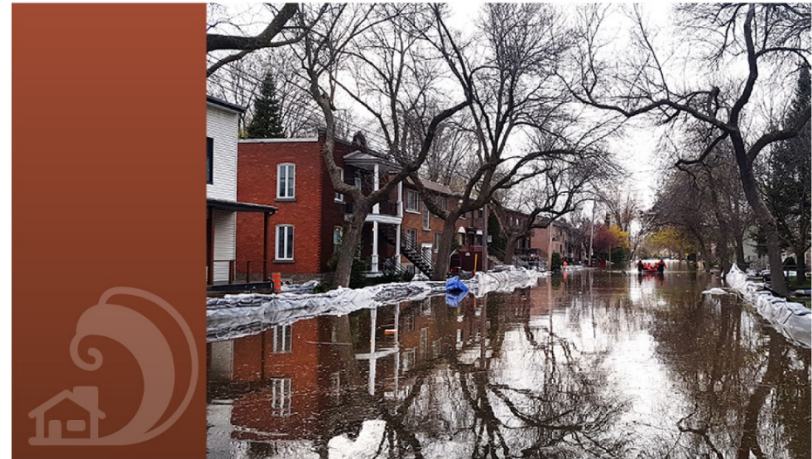
Canadian Space Agency
Agence spatiale
canadienne

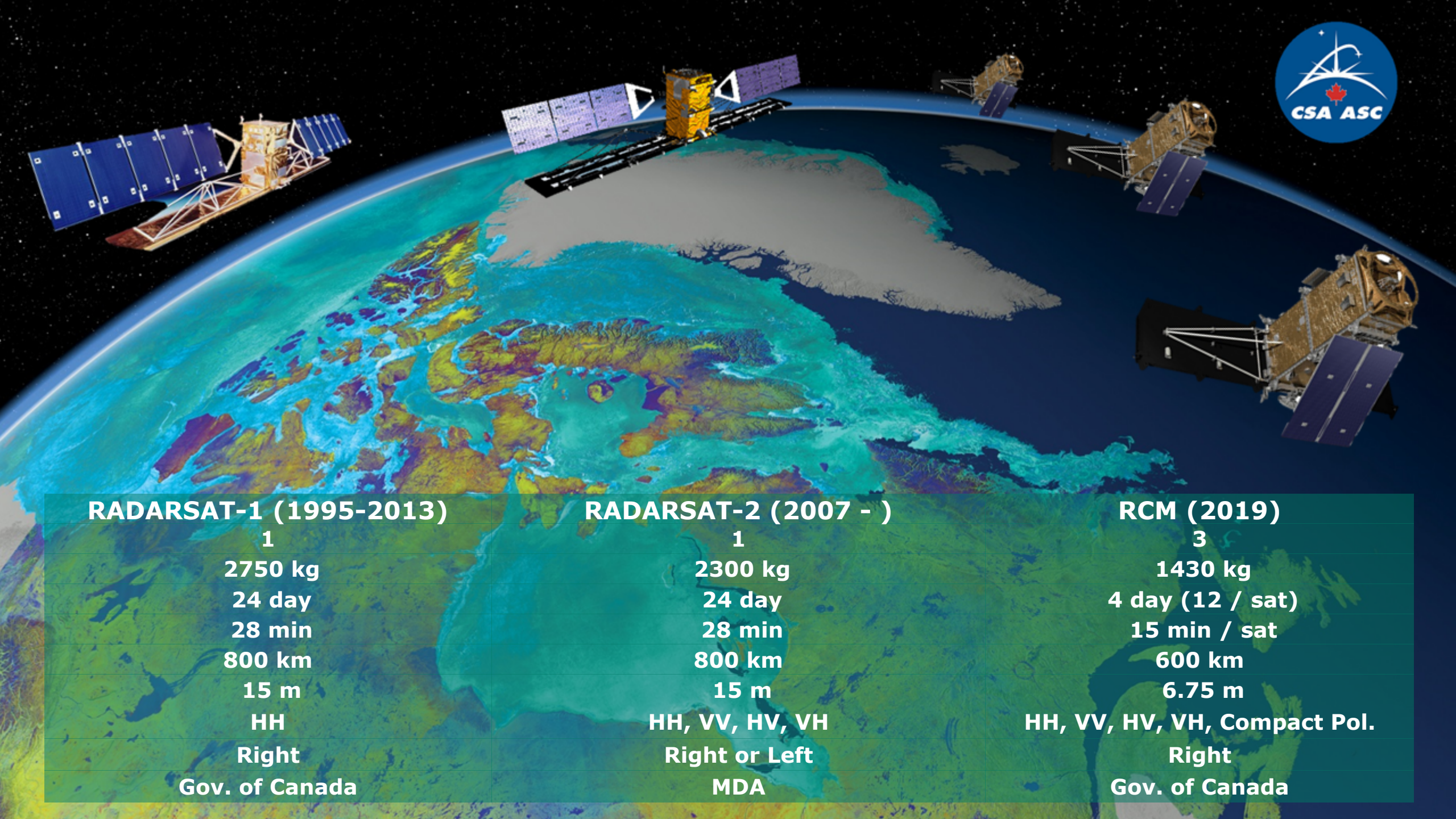
Canada

RADARSAT Constellation Mission

- The evolution of the RADARSAT program with the objectives to:
 - ✓ *Ensure data continuity, and;*
 - ✓ *Respond to the **increasing needs of the Government of Canada for SAR data** to support operations and timely delivery of products and services to Canadians.*
- RCM is a government-owned mission, tailored to respond to the Canadian Government needs in 3 main areas:
 - ✓ *Maritime surveillance*
 - ✓ *Disaster management*
 - ✓ *Ecosystem monitoring*

Canada





RADARSAT-1 (1995-2013)

1

2750 kg

24 day

28 min

800 km

15 m

HH

Right

Gov. of Canada

RADARSAT-2 (2007 -)

1

2300 kg

24 day

28 min

800 km

15 m

HH, VV, HV, VH

Right or Left

MDA

RCM (2019)

3

1430 kg

4 day (12 / sat)

15 min / sat

600 km

6.75 m

HH, VV, HV, VH, Compact Pol.

Right

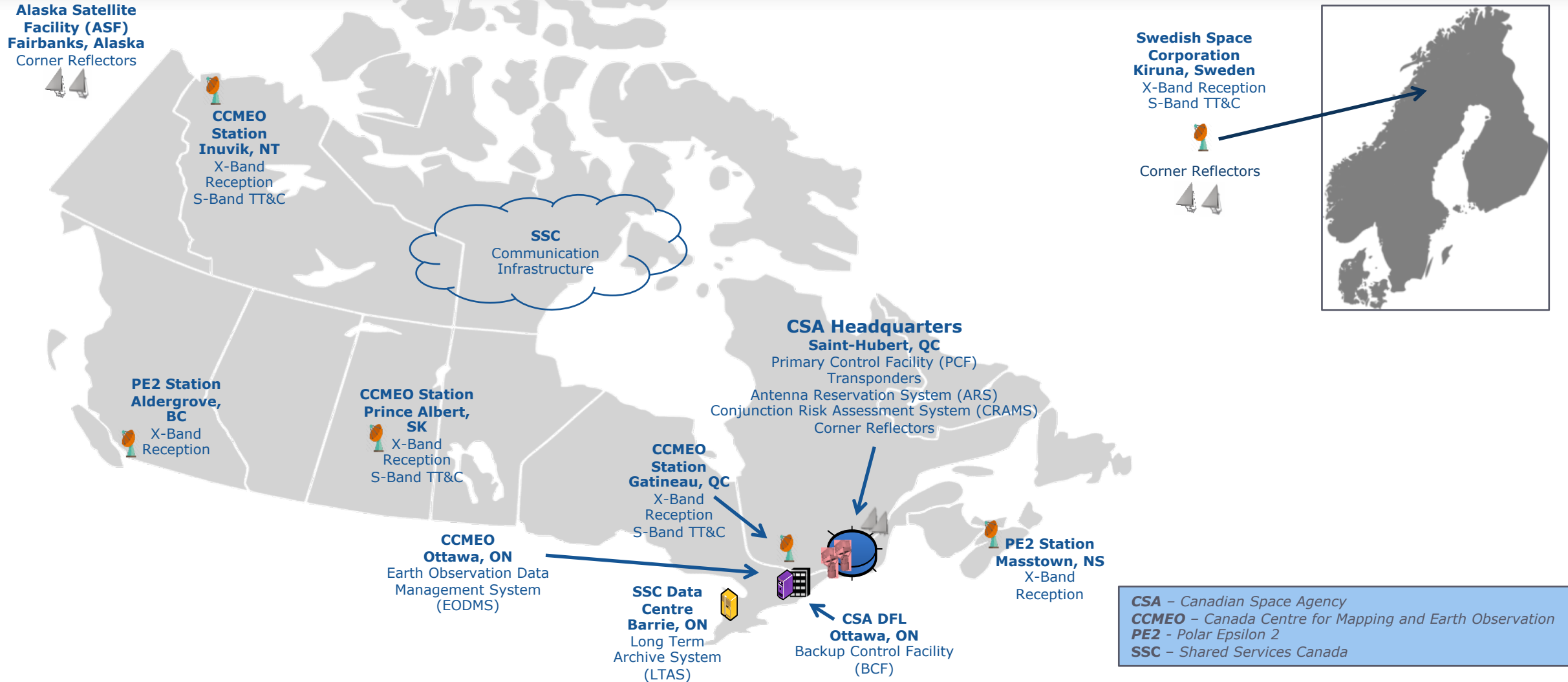
Gov. of Canada

Mission Numbers

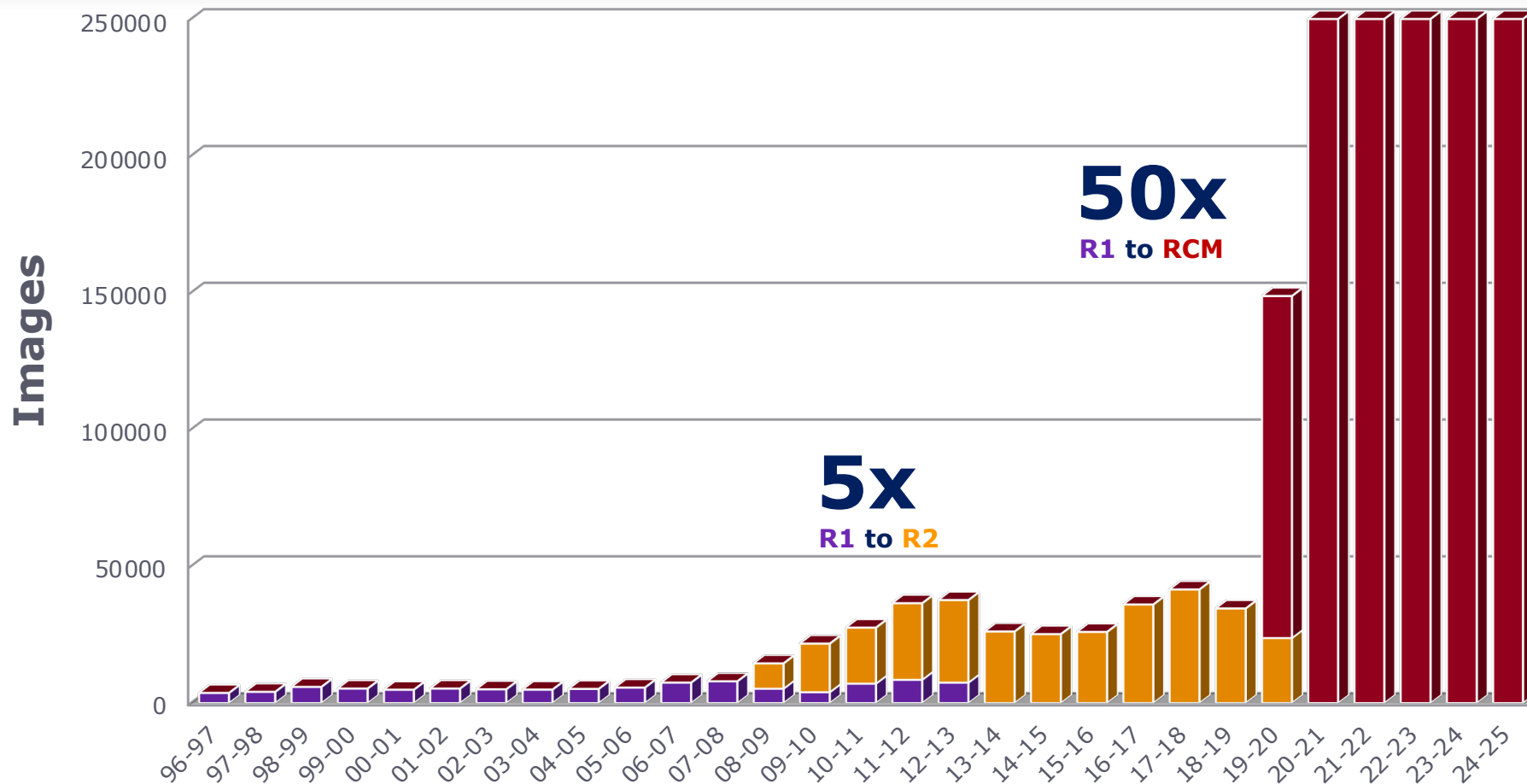
- Evenly spaced satellites on same orbital plane (120 deg.)
- Altitude 600 km, sun-synchronous
- Orbit period of 96.4 minutes
- Orbit maintained within a 100m orbital tube
- Payloads:
 - C-Band SAR – 5.405 GHz
 - Automatic Identification System (AIS)
- 7 years design life
- **Fast tasking capability: 4 hours from order input to satellite tasking**
- **Capability to observe, daily, a chosen point on 90% of the world's surface**



RCM Ground Segment



Evolution of RADARSAT data usage by GoC



1.8TB
DATA PER DAY

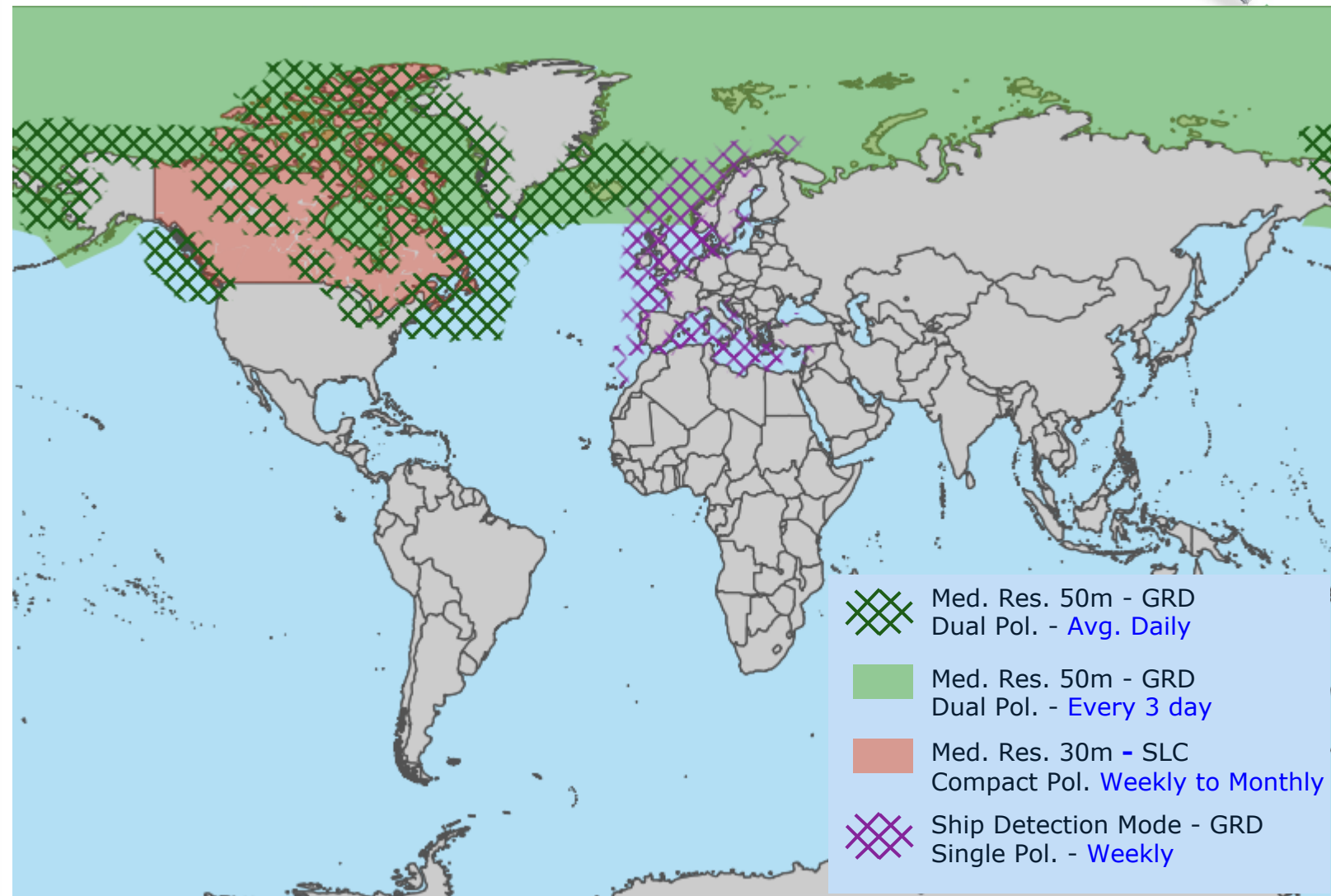
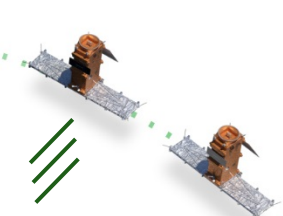
657TB
DATA PER YEAR

4.6PB
DATA AFTER
7 YEARS

GoC user departments forecast to use approximately **250,000** RCM images per year.

RCM Standard Coverages

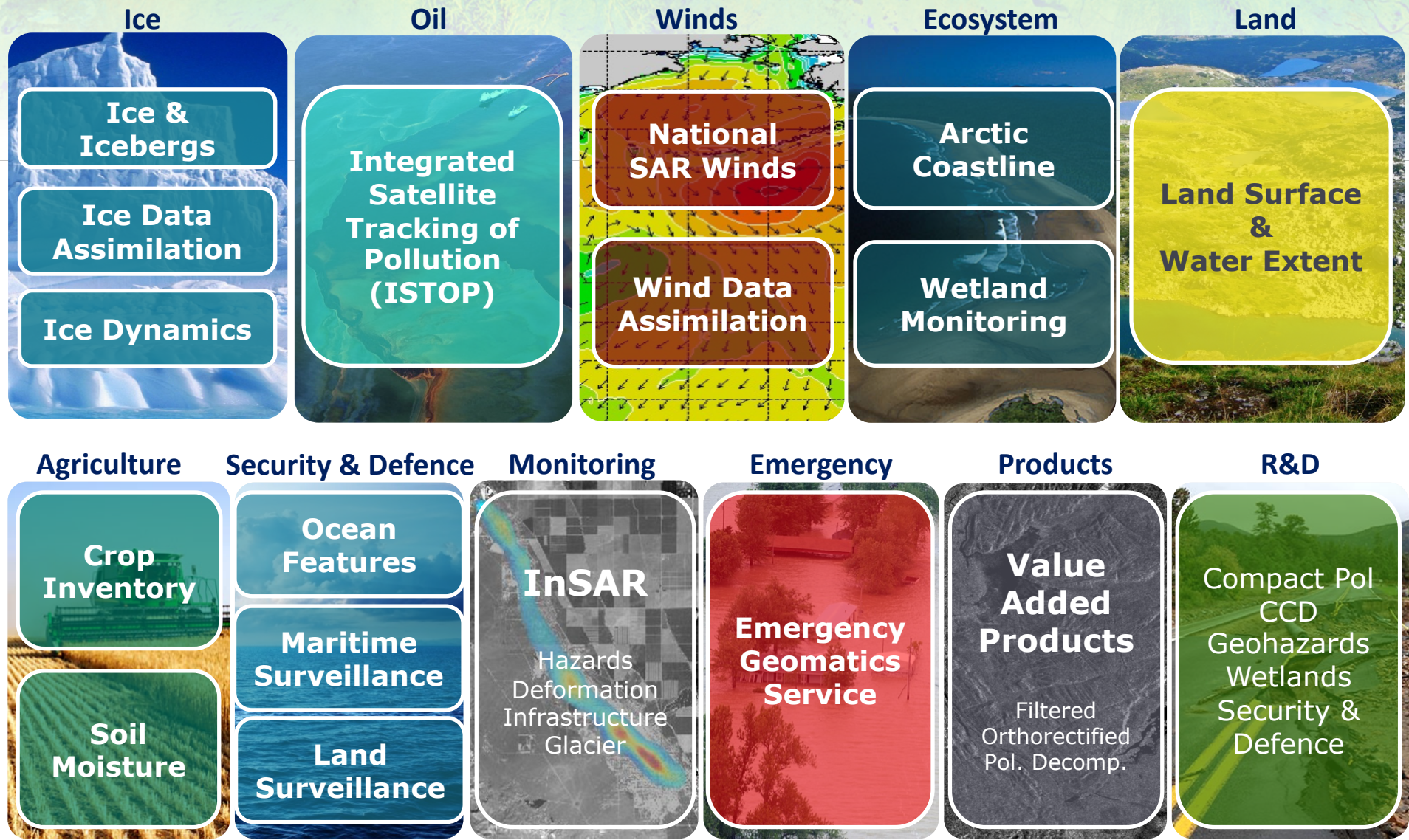
Year-round coverage



Coverage may be changed without notice to meet requirements of the Government of Canada.
Domestic and global coverages that are exclusively for defence and security not shown.

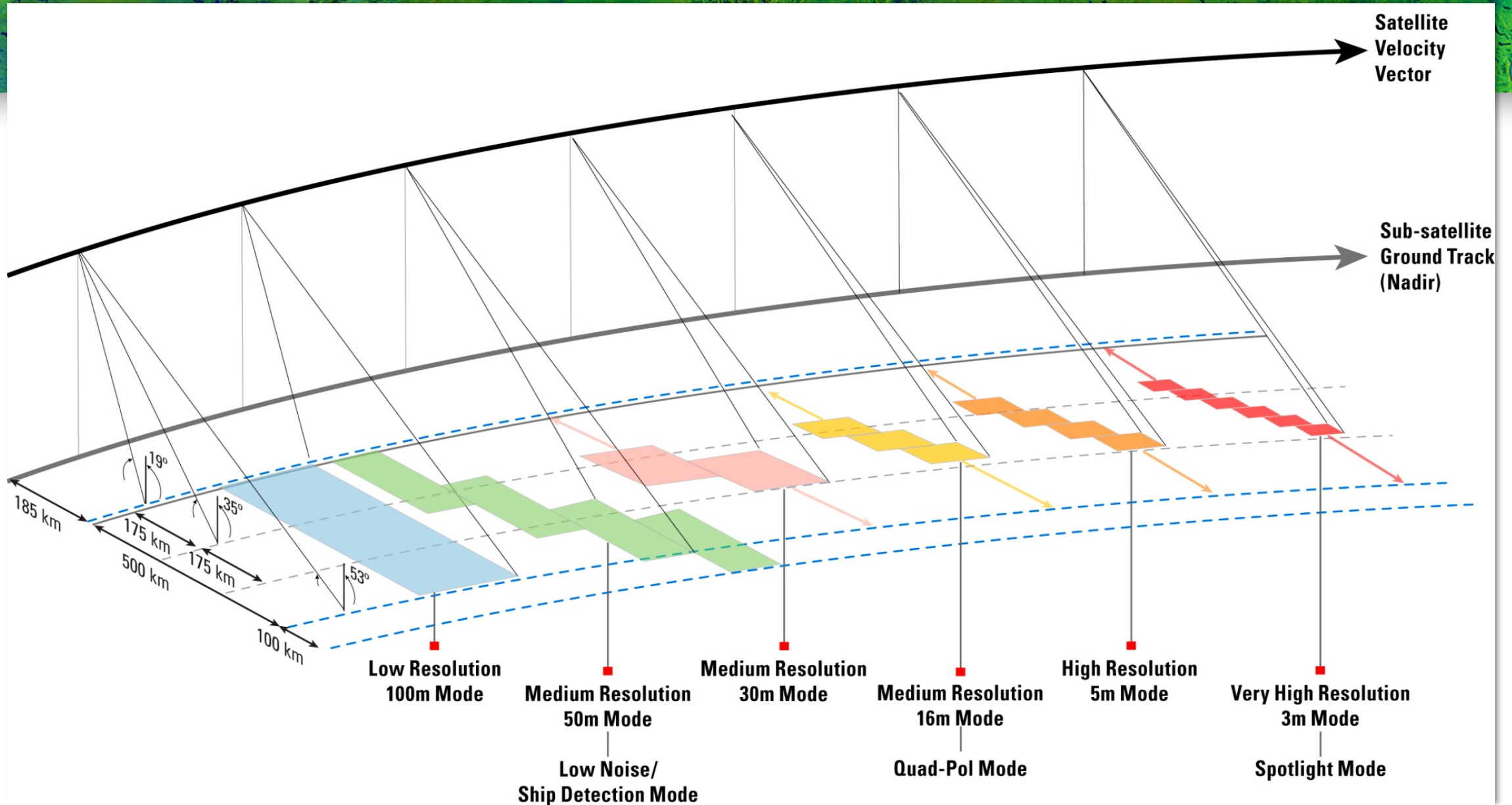
SAR Data Fully Integrated in Government of Canada Service Delivery

-  Environment and Climate Change Canada
-  National Defence
-  Agriculture and Agri-Foods Canada
-  Natural Resources Canada
-  Fisheries and Oceans Canada
-  Parks Canada
-  Public Safety Canada
-  Transport Canada
-  Public Health Agency of Canada
-  Crown-Indigenous Relations and Northern Affairs Canada



RCM acquisitions are planned to supply data required for Government of Canada service delivery to Canadians

Imaging Modes



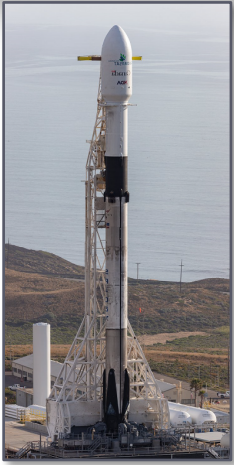
Imaging Modes - Details

Modes	Nominal Resolution m	Number of Looks for detected products rmg x az	Nominal Swath Width (accessible) km	No of Swath Positions	Nominal NESZ dB	Polarization Options					Product Options							
						Single Pol HH, VV, HV or VH	Dual Pol		Compact Pol	Quad Pol HH+VV + HV+VH	Fixed point (16-bit)					Floating point (32-bit)		
							HH+HV or VV+VH	HH+VV ²			SLC	GRD	GRC	GCD	GCC	SLC	GRD	GRC
Low Resolution 100m	100	8x1	500 (500)	1	-22	✓	✓	✓	✓		✓	✓		✓		✓	✓	
Medium Resolution 50m	50	4x1	350 (500)	4	-22	✓	✓	✓	✓		✓	✓		✓		✓	✓	
Medium Resolution 30m	30	2x2	125 (350)	4	-24	✓	✓	✓	✓		✓	✓		✓		✓	✓	
Medium Resolution 16m	16	1x4	30 (350)	16	-25	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
High Resolution 5m	5	1	30 (500)	23	-19	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Very High Resolution 3m	3 @35°	1	20 (500)	42	-17	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Low Noise	100	4x2	350 (500)	4	-25	✓	✓		✓		✓	✓		✓		✓	✓	
Ship Detection	variable	5x1	350 (350)	1	variable	✓	✓		✓		✓	✓				✓	✓	
Quad-Polarization ¹	9	1	20 (250)	21	-24					✓	✓	✓	✓	✓	✓	✓	✓	✓
Spotlight	1 (az) x 3 (grd) @35°	1	20 (350) 5km in az	29	-17	✓	✓		✓		✓	✓		✓		✓	✓	

- 1) There are no performance requirements for the quad-polarization mode: expected performance shown.
- 2) Some performance parameters will be degraded in HH+VV: swath width is reduced to 250km for Low Resolution 100m and to 175km for Medium Resolution 50m; number of looks in azimuth is reduced to one for Medium Resolution 30m and two for Medium Resolution 16m; azimuth resolution is degraded to 10m for High Resolution 5m and to 6m to 8m for Very High Resolution 3m. Complex products (SLC, GRC or GCC) are not available for the HH+VV polarization.



RCM Status



Credit: SpaceX

- Launch and Early Orbit (LEOP) phase completed June 18.
- 1st Engineering Image published June 29.
- More than 5,000 images have been acquired from all three satellites since start of commissioning.
- SAR Data Policy released in August.
- Successful Commissioning Nov 14.
- Phased operation transition to RCM has begun.



Second RADARSAT Constellation Mission satellite separates from the Falcon 9 rocket.

RCM Calibration Validation: Image Quality Subsystem

IQS

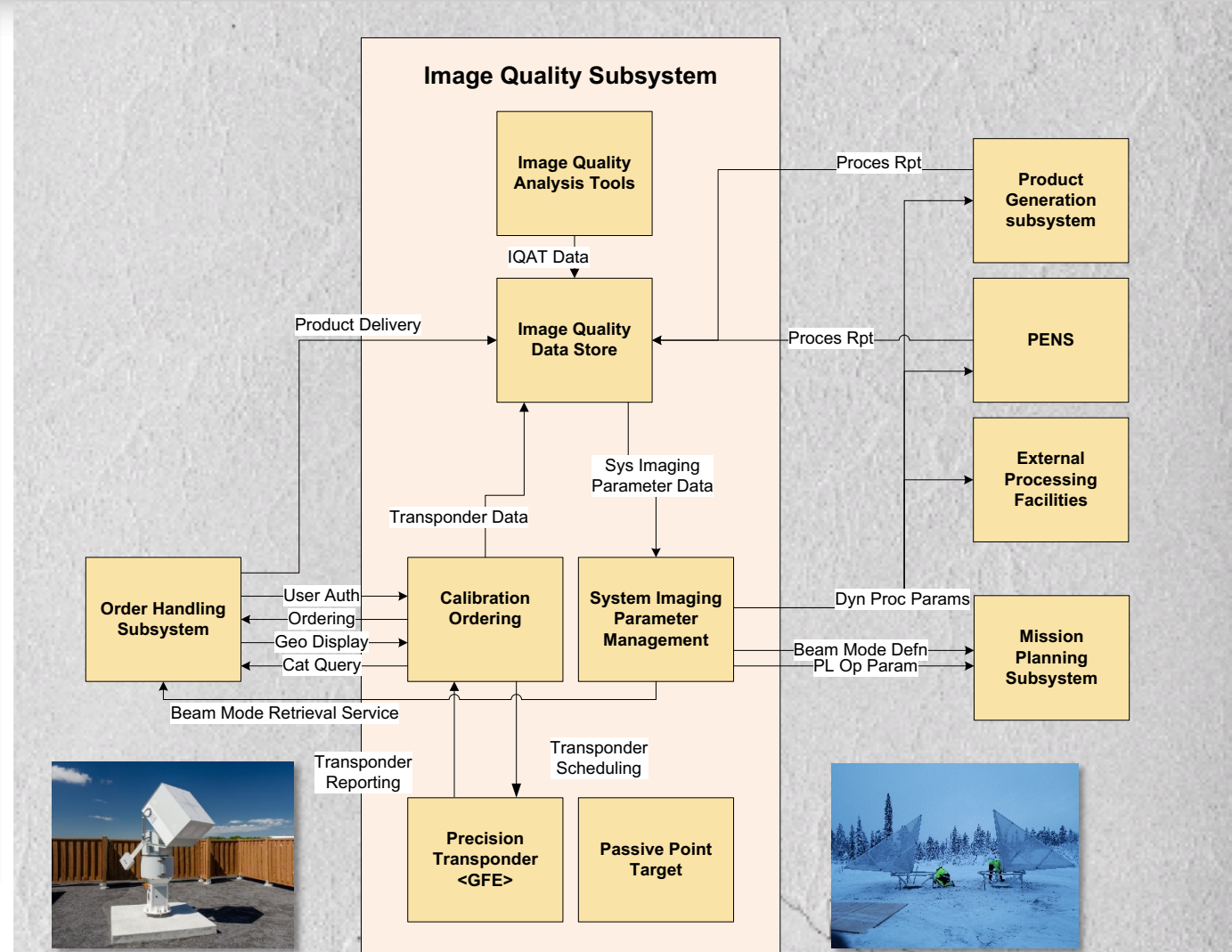
IQS Core Component provides analysis capabilities for calibration activities:

1. Image Quality Analysis

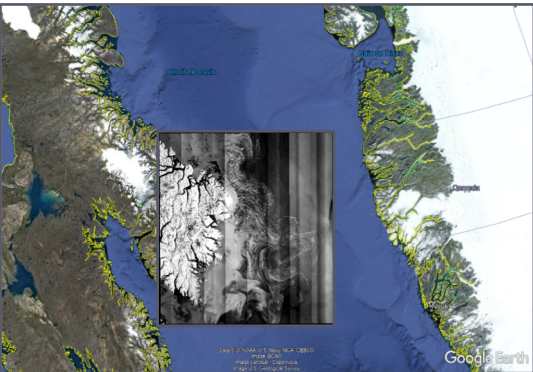
- Point target analysis (CRs and transponders)
- Distributed target analysis
- Beam pattern analysis
- Polarimetric analysis
- Noise analysis
- 2D bandwidth overlap measurement
- Non-imaging calibration analysis
- Coverage analysis

2. Statistics and Trending

Reference sites: Amazon basin, corner reflector, precision transponders



First RCM Engineering Image



Qikiqtarjuaq, Baffin Island, Nunavut

2019-06-29

10:24:35 UTC

Descending

Low Noise ScanSAR

100m x 100m

350 km

HH

3-bit BAQ

GRD Product

Commissioning

Spacecraft initial attitude

- Pitch bias (ADCS timing issue)
- Incorrect sign in yaw steering
- Manifested as large geolocation errors and IQ issues
- Large roll bias on RCM-2

ScanSAR image quality issues (resolved)

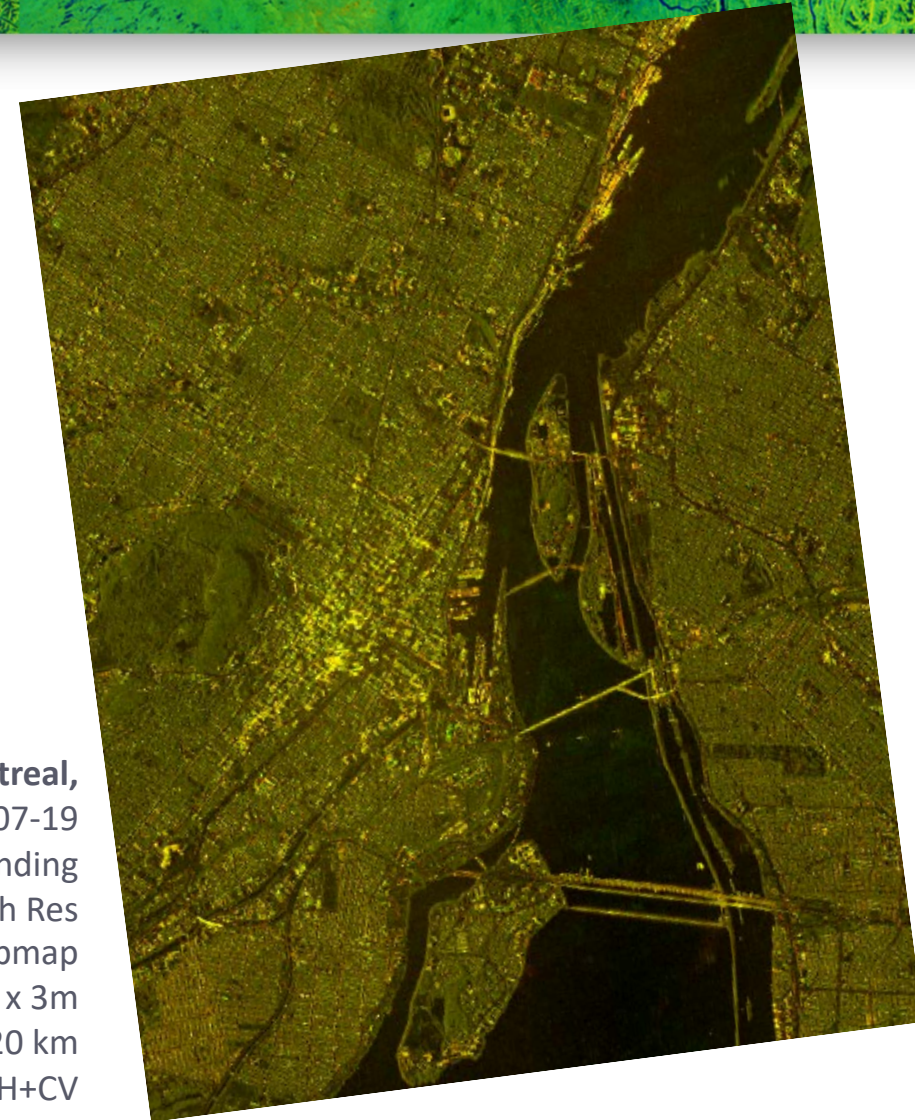
- Incorrectly commanded "stepped receive"
- ScanSAR missing beams (payload timing)
- Fully corrected via ground configuration

Spacecraft CCRs leading to the CCCR

Initial Calibration Metrics:

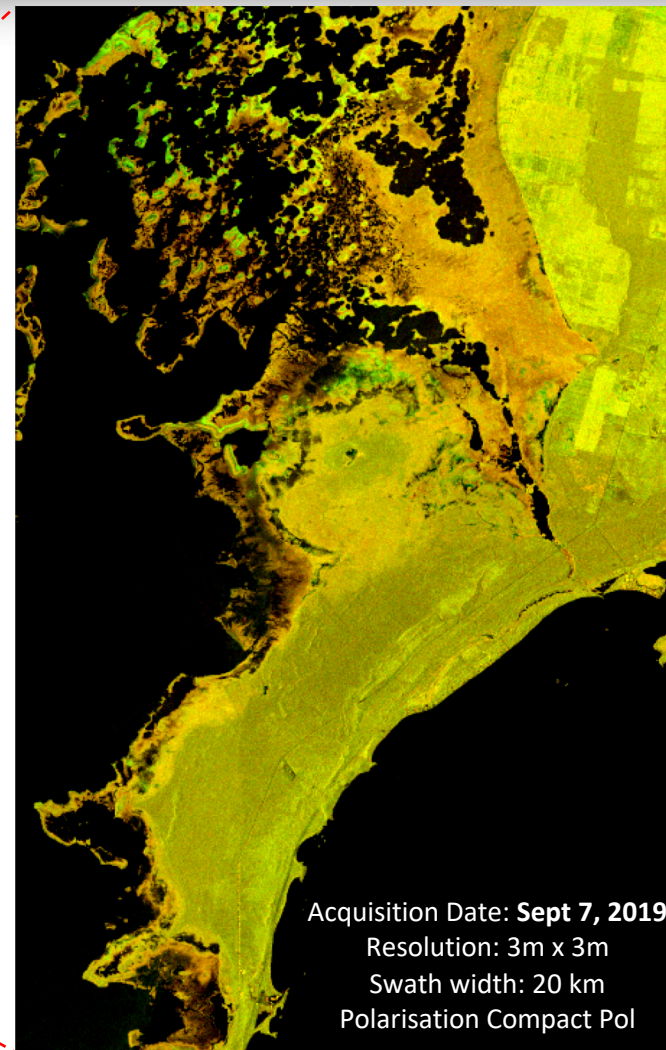
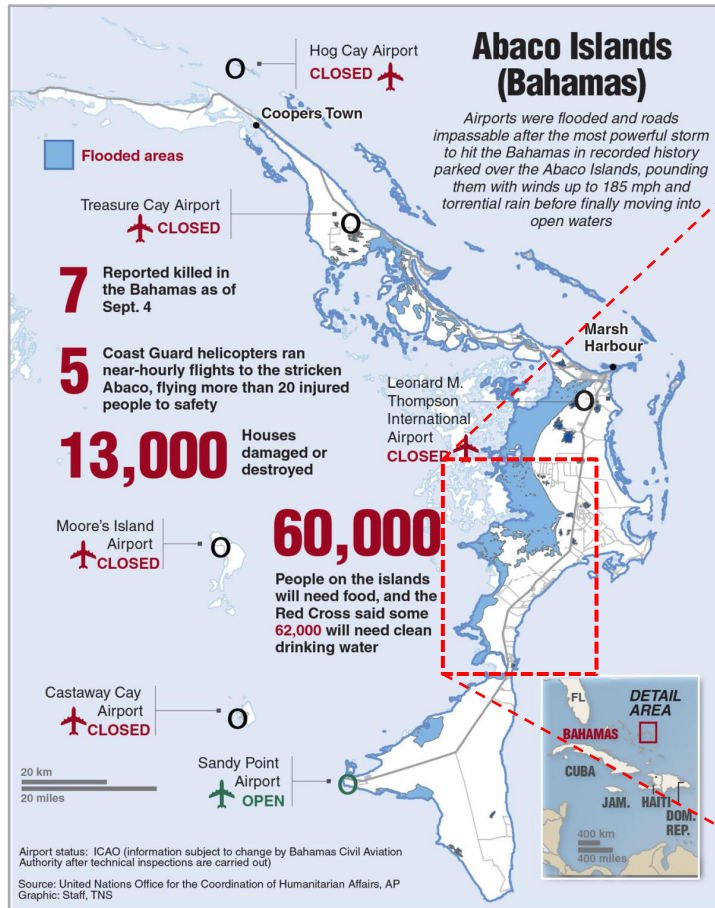
- Resolution
- Geolocation
- Radiometry
- Full Polarimetry
- Compact Polarimetry
- CCD

Montreal,
2019-07-19
Ascending
Very High Res
Stripmap
3m x 3m
20 km
CH+CV

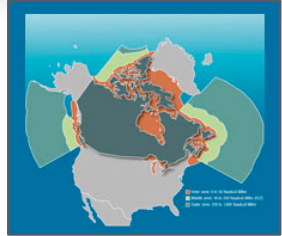




Improved response to disaster events



What's new with RCM - Highlights



Average daily complete coverage of Canada's land and maritime approaches

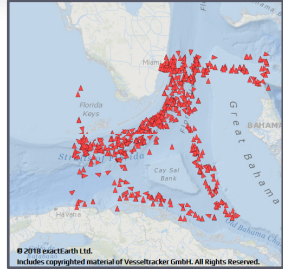


Ability to observe daily a chosen point on 90% of the world's surface + Fast Tasking (4 hour)

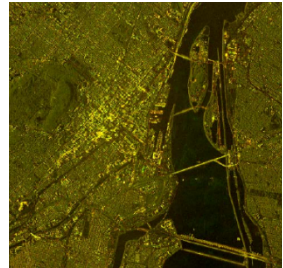
4-day repeat pass for CCD (spacecraft-to-spacecraft CCD with stepped receive ScanSAR)



Secondary payload - Automatic Identification System (AIS) for ship detection and identification



Circular Compact Polarization (all modes) + Multi-polarization on High (5m) and Very High (3m) resolution modes

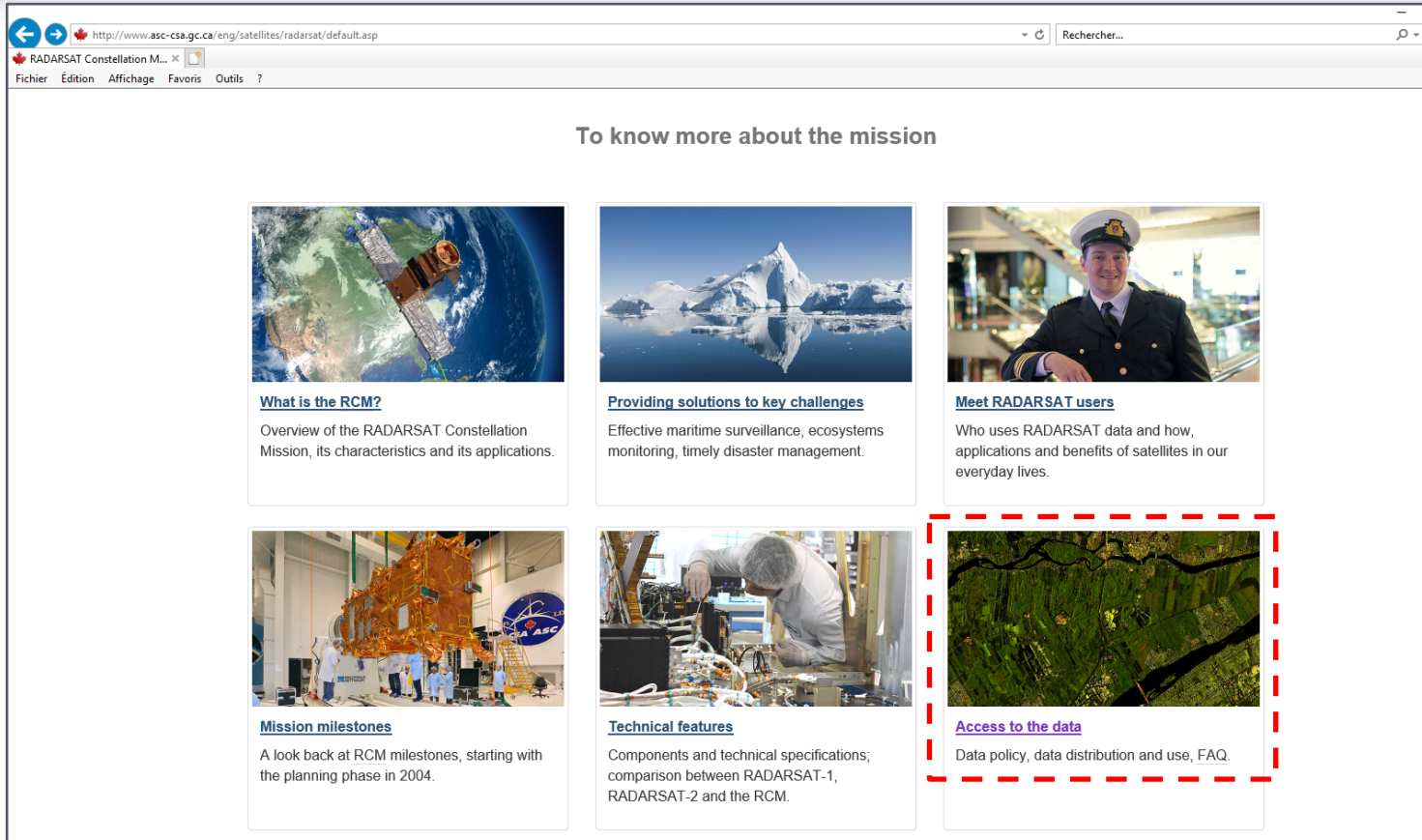


Next Steps:

- Operation phase-in with users, transitioning to RCM
- Initiate Standard Coverage submissions
- Consolidate calibration numbers and operationalize cal-val monitoring
- Finalize and integrate data access and data use modalities (EULA, vetting)



RCM SAR Data Policy



The screenshot shows a web browser window with the URL <http://www.asc-csa.gc.ca/eng/satellites/radarsat/default.asp>. The page title is "RADARSAT Constellation Mission" and the browser menu includes "Fichier", "Édition", "Affichage", "Favoris", and "Outils". The main content area is titled "To know more about the mission" and features six cards:

- What is the RCM?**: Overview of the RADARSAT Constellation Mission, its characteristics and its applications.
- Providing solutions to key challenges**: Effective maritime surveillance, ecosystems monitoring, timely disaster management.
- Meet RADARSAT users**: Who uses RADARSAT data and how, applications and benefits of satellites in our everyday lives.
- Mission milestones**: A look back at RCM milestones, starting with the planning phase in 2004.
- Technical features**: Components and technical specifications; comparison between RADARSAT-1, RADARSAT-2 and the RCM.
- Access to the data**: Data policy, data distribution and use, FAQ. (This card is highlighted with a red dashed border in the original image.)

Canadian Space Agency RADARSAT Constellation Mission

SAR Data Policy

Revision: Initial Release (IR)
August, 2019

Web: www.asc-csa.gc.ca/rcm
Email: asc.mcr-info-rcm-info.csa@canada.ca



Canadian suppliers*

NOVA SCOTIA

Bradean's Tool and Die - Amherst
MDA, a Maxar company - Dartmouth
IMP Group - Halifax
STELIA Aerospace - Lunenburg

QUEBEC

F.J. Machine Shop - Baie-D'Urfé
C&R Développement - Gatineau
CMR Summit Technologies - Pointe-Claire
MDA, a Maxar company - Sainte-Anne-de-Bellevue
Mecachrome - Mirabel
Apex Precision - Saint-Lazare
JLM - Saint-Augustin-de-Desmaures
Sonaca - Mirabel
Atelier d'usinage - Vaudreuil-Dorion
Pierre Fortier

ONTARIO

COM DEV - Cambridge
Hi-Rel Alloys - Niagara Falls
Filtran - Kanata
Wejay - Kingston
ITL Circuits - Markham
FTG - Scarborough
A-Line/Muru - Toronto

BRITISH COLUMBIA

MDA, a Maxar company - Richmond

MANITOBA

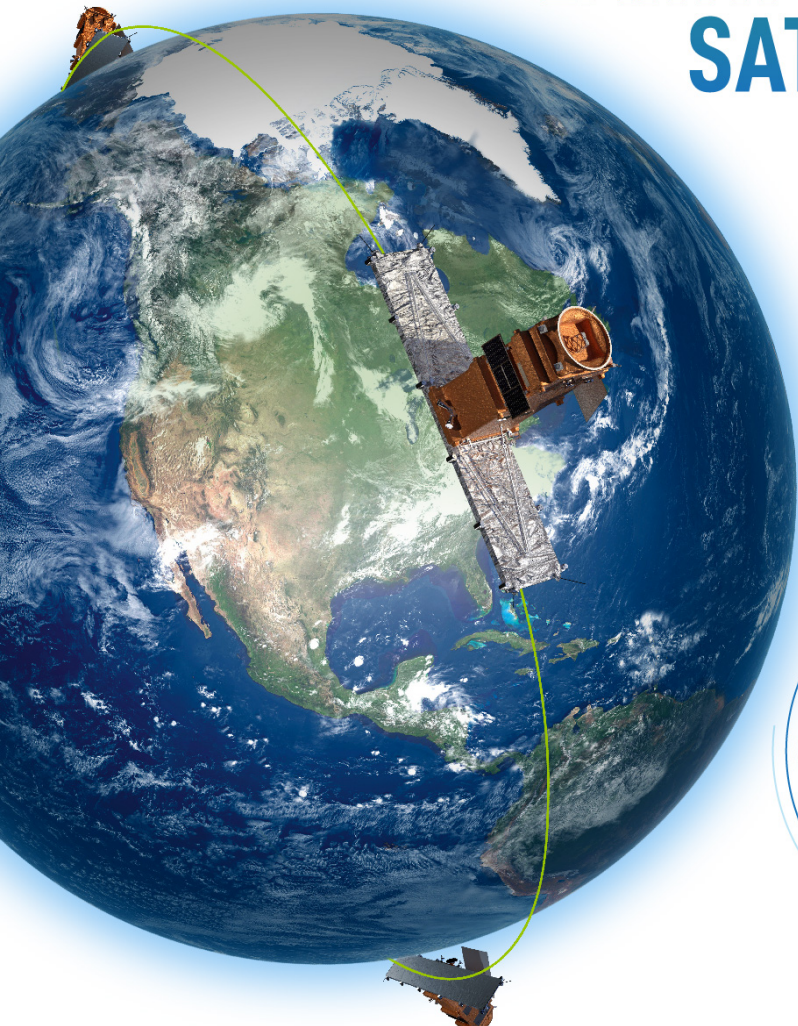
Magellan Aerospace - Winnipeg

*Companies listed on the illustration are the main suppliers in terms of contract dollars spent. In total, there are over 125 suppliers in seven Canadian provinces.



RADARSAT Constellation Mission:

CANADA'S NEW GENERATION OF EARTH OBSERVATION SATELLITES



MAIN USES:



Monitor the **environment**, **oceans** and **ice**; support **emergency teams** during **natural disasters**; **detect ships**



LAUNCH:
Spring 2019
aboard a
SpaceX
Falcon 9
rocket



3 IDENTICAL SATELLITES
working together



APPROXIMATELY 250,000 IMAGES PER YEAR
will be used

50 times more than the first generation of RADARSAT

SPEED:
27,200 km/h
One Earth orbit every **96 minutes**

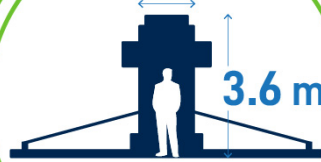


ALTITUDE:
600 km

1.1 m

3.6 m

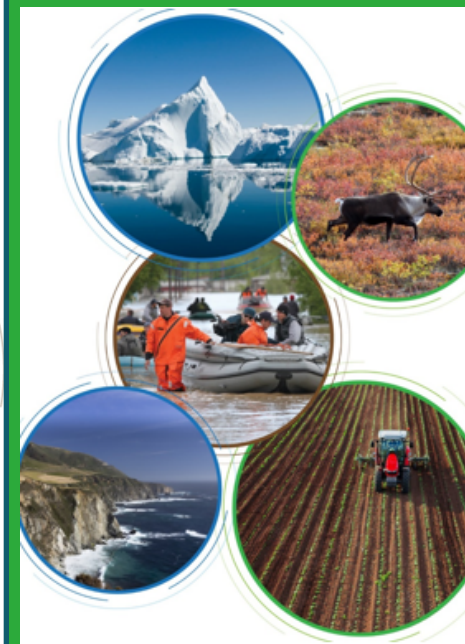
6.98 m



MASS:
1,430 kg each
(like a black rhino)



THANK YOU!



www.asc-csa.gc.ca/rcm

RCM SAR Data Policy and Access in Brief

Acquisition

- Government of Canada task the satellites, though Standard Coverages and ad hoc acquisitions
- Industry, non-GoC governments and academic users

Access Distribution

- Data distribution is non-commercial: Standard Coverage image products to be made available to users via NRCan's EO Data Management System
- Registration is required to access data
- Additional vetting to provide greater data access

Ownership and Use

- Ownership of RCM SAR data is with the GoC
- IP rights to Value Added Products (VAPs) remain with creators
- Conditions of use of the RCM SAR data specified in EULAs

In Canada, the **Remote Sensing Space Systems Act** prescribes operating licenses for EO satellite missions to be operated, with implications in terms of data access



asc-csa.gc.ca



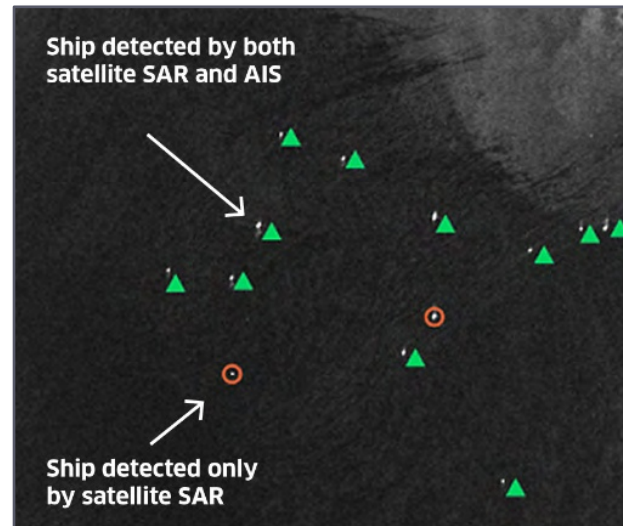
Questions on RCM

asc.mcr-info-rcm-info.csa@canada.ca



Automatic Identification System (AIS)

- AIS is a National Defence sensor.
- Each RCM satellite includes a receiver for AIS transmissions from vessels.
- Using AIS in conjunction with SAR allows improved detection and tracking of vessels, and improved surveillance timeliness.



Standard Coverages

Standard Coverages are SAR data acquisition plans that are based on the imaging needs of the Government of Canada.

They:

- cover predominantly the Canadian AOI
- are designed to offer consistent and predictable SAR coverage based on long-lead planning
- provide departments with coordinated acquisition plans reducing imaging conflicts to achieve satisfactory coverage for their application
- are intended to have a long lifespan
- are managed by the Standard Coverage Working Group (SCWG), a group tasked with defining requirements and coordinating coverages within the GoC, and order submission into the RCM



Coordinated
Demand

Optimized
Planning

Maximized
use of RCM