Canadian Space Agency | Agence spatiale canadienne

From RADARSAT-2 to RADARSAT Constellation Mission data continuity

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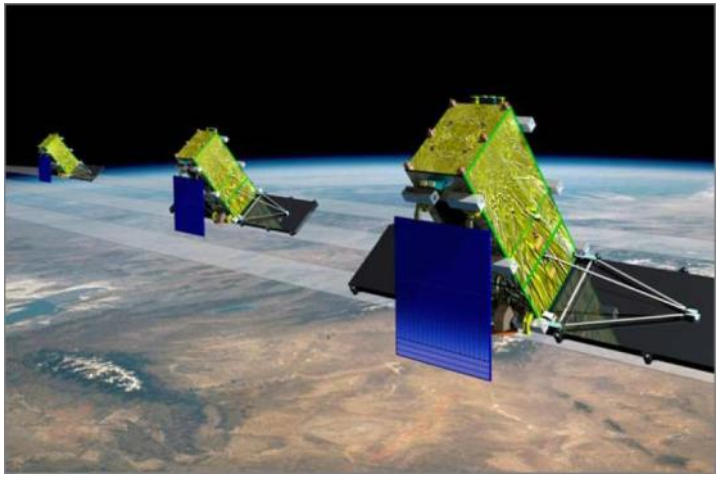
****Presented by Paris W. Vachon***

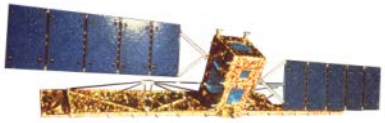


SeaSAR June 18-22 , 2012

Canada

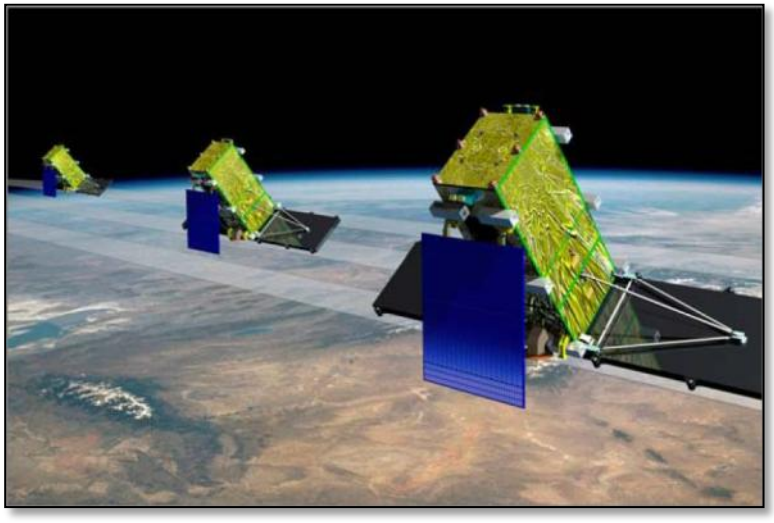
Outline

- **RADARSAT-1 / 2 data continuity**
- **RCM**
  - ✓ Mission Description
  - ✓ Data Products
  - ✓ Mission Update
  - ✓ Data Policy
- **ESA-CSA collaboration**



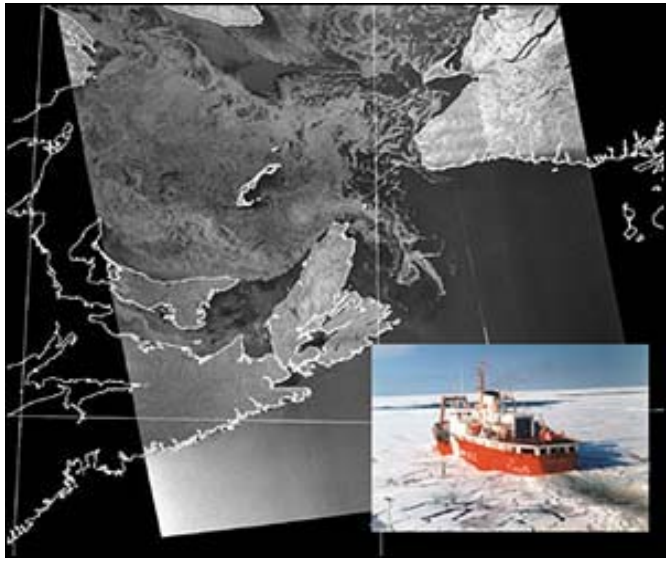
RADARSAT-1

RADARSAT-2



RADARSAT Data Continuity

1995: RADARSAT-1

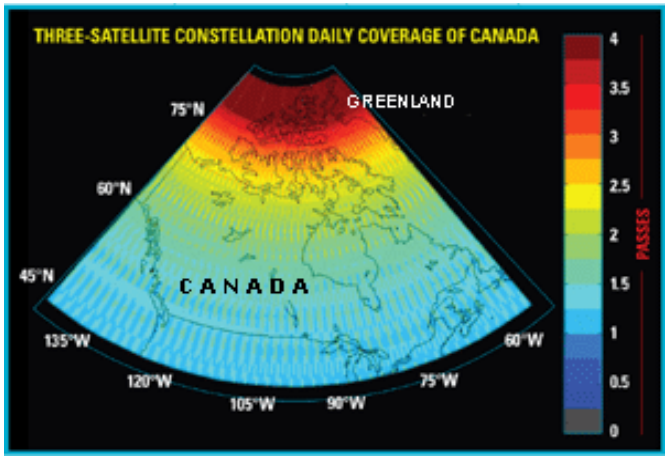


5 000 images/yr
Processing $$$
Data Access CDs

2007: RADARSAT-2

30 000 images/yr
Processing $
Data Access FTP

2016/17: RCM



Expected
300 000 images/yr

Evolution of the RADARSAT Series

- RADARSAT-1
  - Monitor the Canadian Arctic
  - Radar for ice and marine applications
  - R&D focus
  - One operational user: Environment Canada
- RADARSAT-2
  - R&D within many departments
  - Two operational users: EC and DND (PE)
- RADARSAT Constellation Mission (RCM)
  - Operational focus

RADARSAT-1

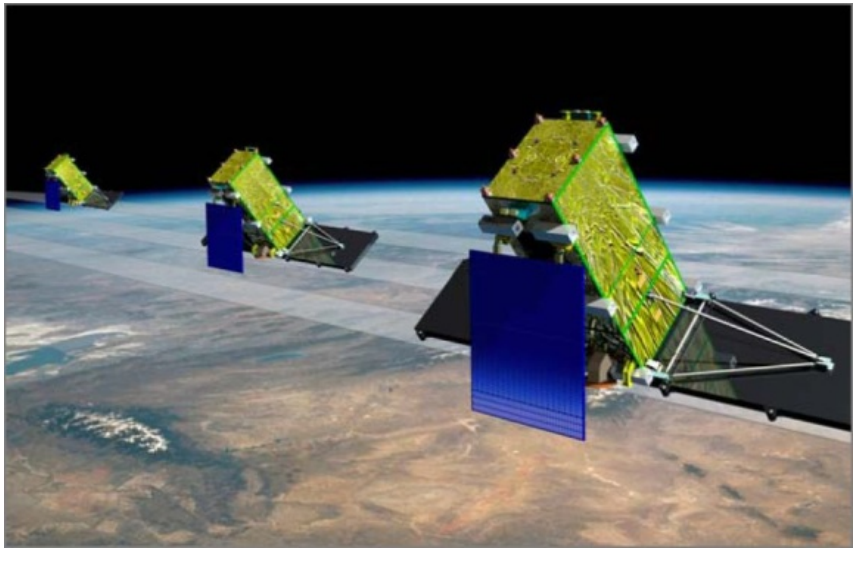
- Launched November 1995
- Government-owned and operated
- Two parties to the data policy: CSA and the USA (NASA and NOAA)
- Assign exclusive right to commercially distribute data to MDA (formerly RSI)
- Fostered the emergence of a new data reselling business
- Royalties to GoC

RADARSAT-2

- Launched December 2007
- Privately-owned and operated by MDA
- Market-driven data policy: MDA has a world-wide network of data resellers
- $446M pre-paid data credit for GoC to finance cost of mission and fulfill GoC data needs
- Remote Sensing Space Systems Act (RSSSA) was enacted in 2005 and imposed restrictions on data distribution

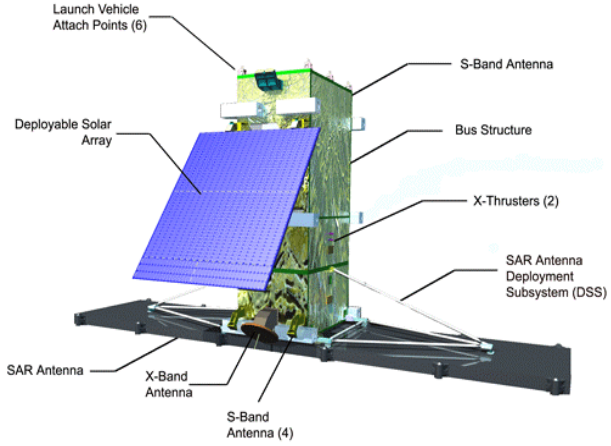
RADARSAT Constellation Mission

- Planned for launch in 2016 and 2017
- RCM has greater imaging capacity (frequency) and will be launched near the exhaustion of the R-2 GoC data credit
- Developed to meet the needs of operational users

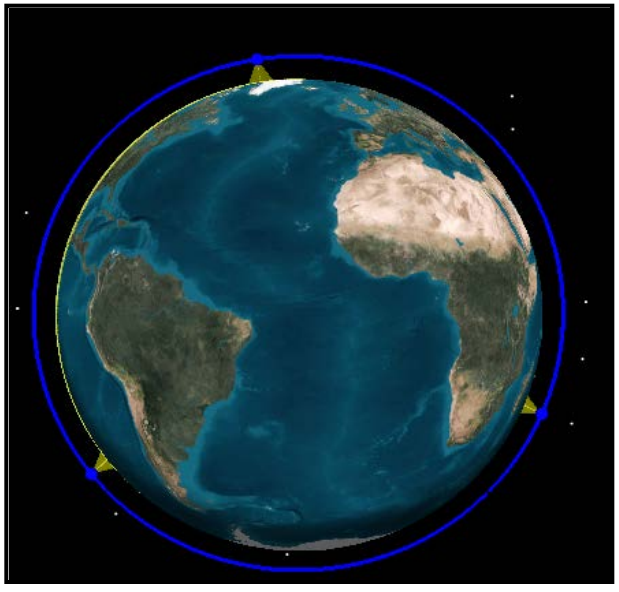


System Description

Bus	**Canadian Smallsat Bus**
Launcher	**Falcon 9 specifications (for design)**
Total Mass	**1400 kg**
Antenna	**9.45m^2**
Power	**<1600 W peak; <220 W average**
Orbit	**600 km, 100 m radius orbital tube**
Polarisation	**Single Pol / Dual cross selectable pol & Compact polarimetry available on all modes; One fully polarimetric mode**
Imaging Time	**12 minutes/orbit (peak 20 minutes every three orbits)** **10 minutes continuous imaging**
Lifetime	**7 years (each satellite)**

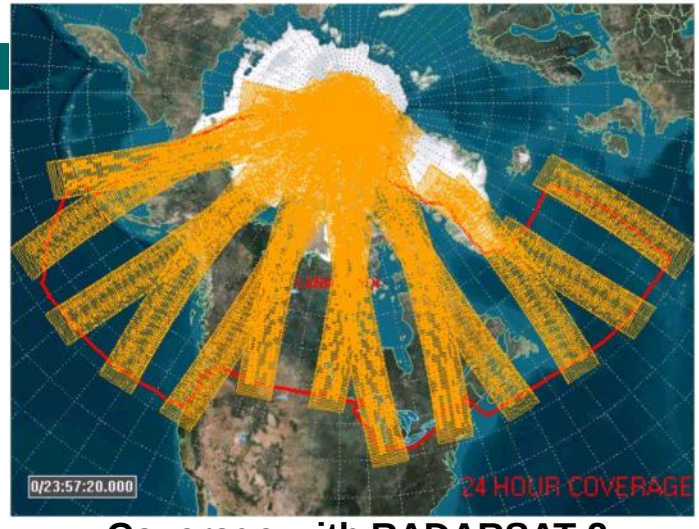


Drawing courtesy of MDA Systems Ltd



Mission Requirements

- Based on GoC users requirements
- Average daily coverage of Canadian waters and regular land coverage
- Average daily global access
- Data analyzed in near-real time for operational applications
- 4-day Coherent Change Detection using SAR interferometry
- Gradual implementation with two launches separated by 16 months



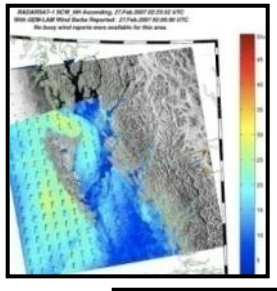
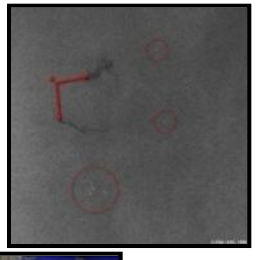
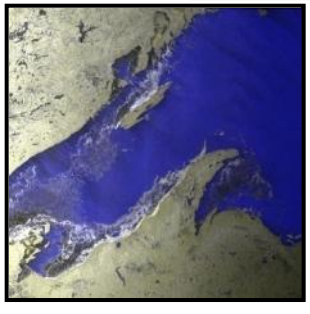
Coverage with RADARSAT-2

Coverage with RCM

Core Use Areas

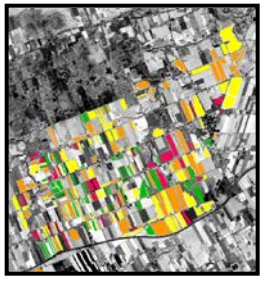
Maritime Surveillance

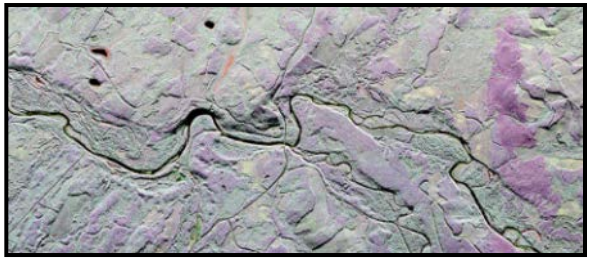
- Ice & Iceberg Monitoring
- Pollution Monitoring
- Vessel Detection
  - Including AIS
- Marine Winds

Environmental Monitoring

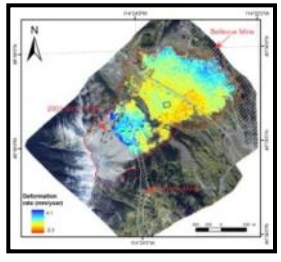
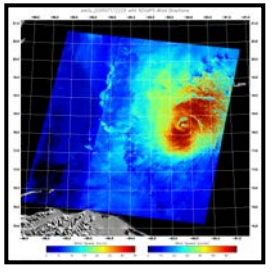
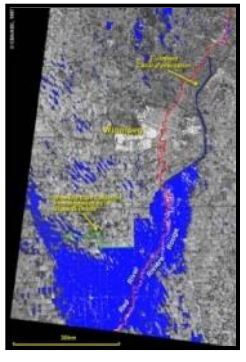
- Forestry
- Protected Areas & Wildlife Habitat
- Agriculture
- Wetlands
- Coastal Change



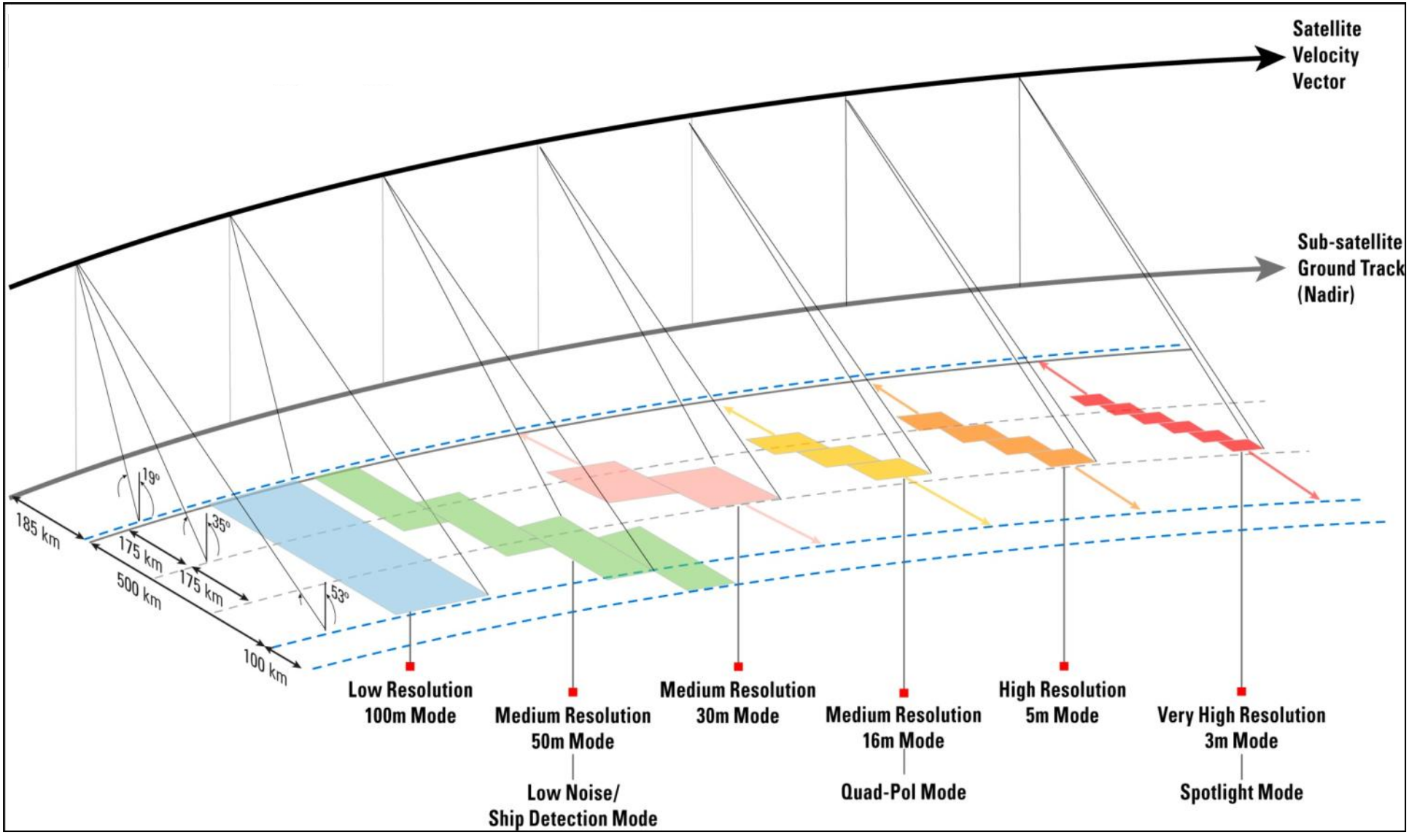


Disaster Management

- Flood Monitoring
- Windstorms
- Earthquakes
- Landslides
- Volcanic Activity
- Permafrost

Imaging Modes

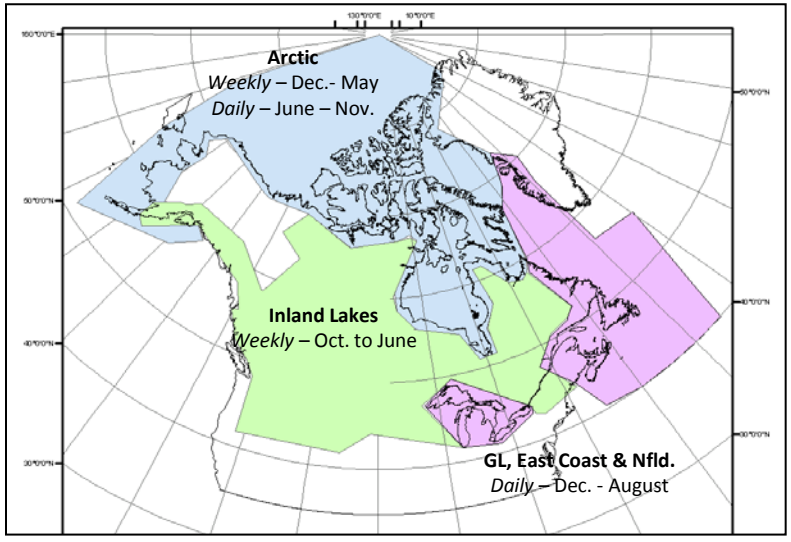


Mode Details

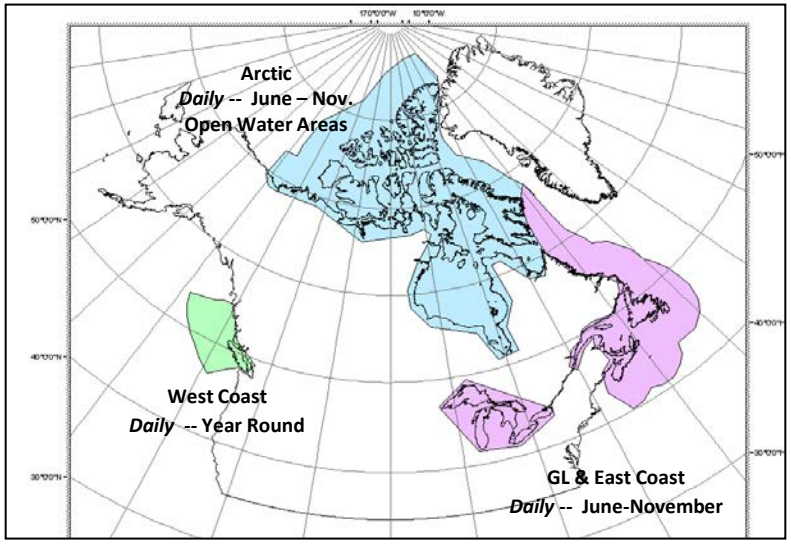
Mode	Nom. Res. m	Num Looks rng x az	Nominal Swath Width (accessible) km	Min Along Track Length km	Nom-inal NESZ dB	Polarization Options								
						Single Pol				Dual Pol				Quad Pol
						HH	VV	HV	VH	HH+HV	VV+VH	HH+VV	Compact	HH+VV+ HV+VH
Low Resolution 100m	100	8x1	500 (500)	10	-22	✓	✓	✓	✓	✓	✓	✓	✓	
Medium Resolution 50m	50	4x1	350 (500)	10	-22	✓	✓	✓	✓	✓	✓	✓	✓	
Medium Resolution 16m	16	1x4	30 (350)	10	-25	✓	✓	✓	✓	✓	✓	✓	✓	
Medium Resolution 30m	30	2x2	125 (350)	10	-24	✓	✓	✓	✓	✓	✓	✓	✓	
High Resolution 5m	5	1	30 (500)	10	-19	✓	✓	✓	✓	✓	✓	✓	✓	
Very High Resolution 3m	3 @35°	1	20 (500)	10	-17	✓	✓	✓	✓	✓	✓	✓	✓	
Low Noise	100	4x2	350 (500)	10	-25	✓	✓	✓	✓	✓	✓		✓	
Ship Detection	var.	var.	350 (600)	10	var.	✓	✓	✓	✓	✓	✓		✓	
Quad-Polarization	NR[1]	NR[1]	> 20 (NR[1])	10	NR[1]									✓
Spotlight	1 (az) x 3 (grd) @35°	1	20 (350)	5	-17	✓	✓	✓	✓	✓	✓		✓	

[1] NR – No requirement specified

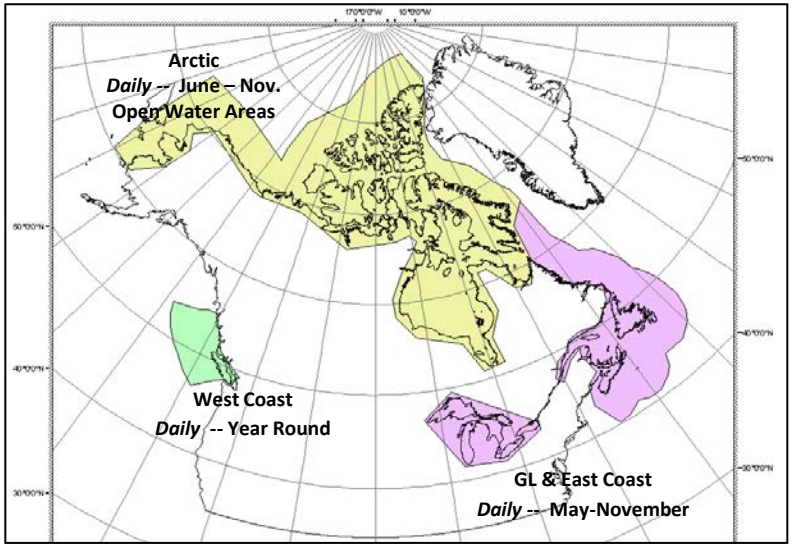
Maritime Operational Needs



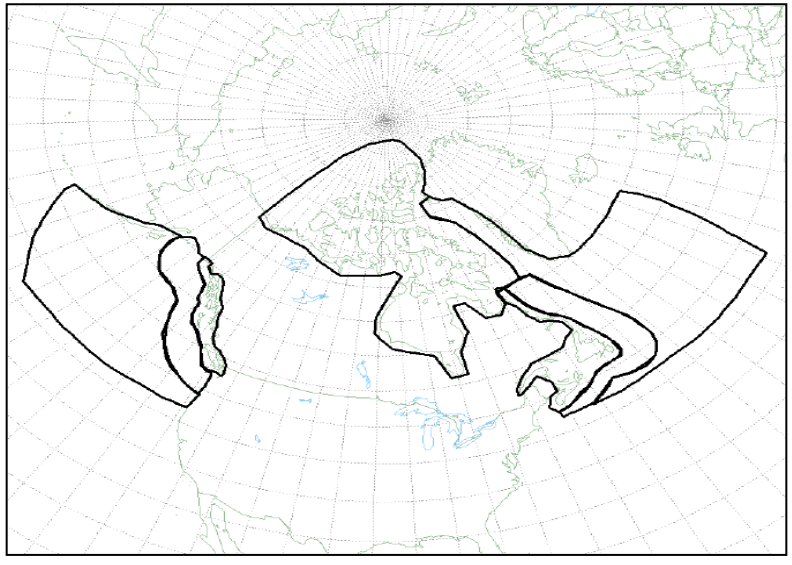
Ice Monitoring



Oil Pollution



Marine Winds



Ship Detection

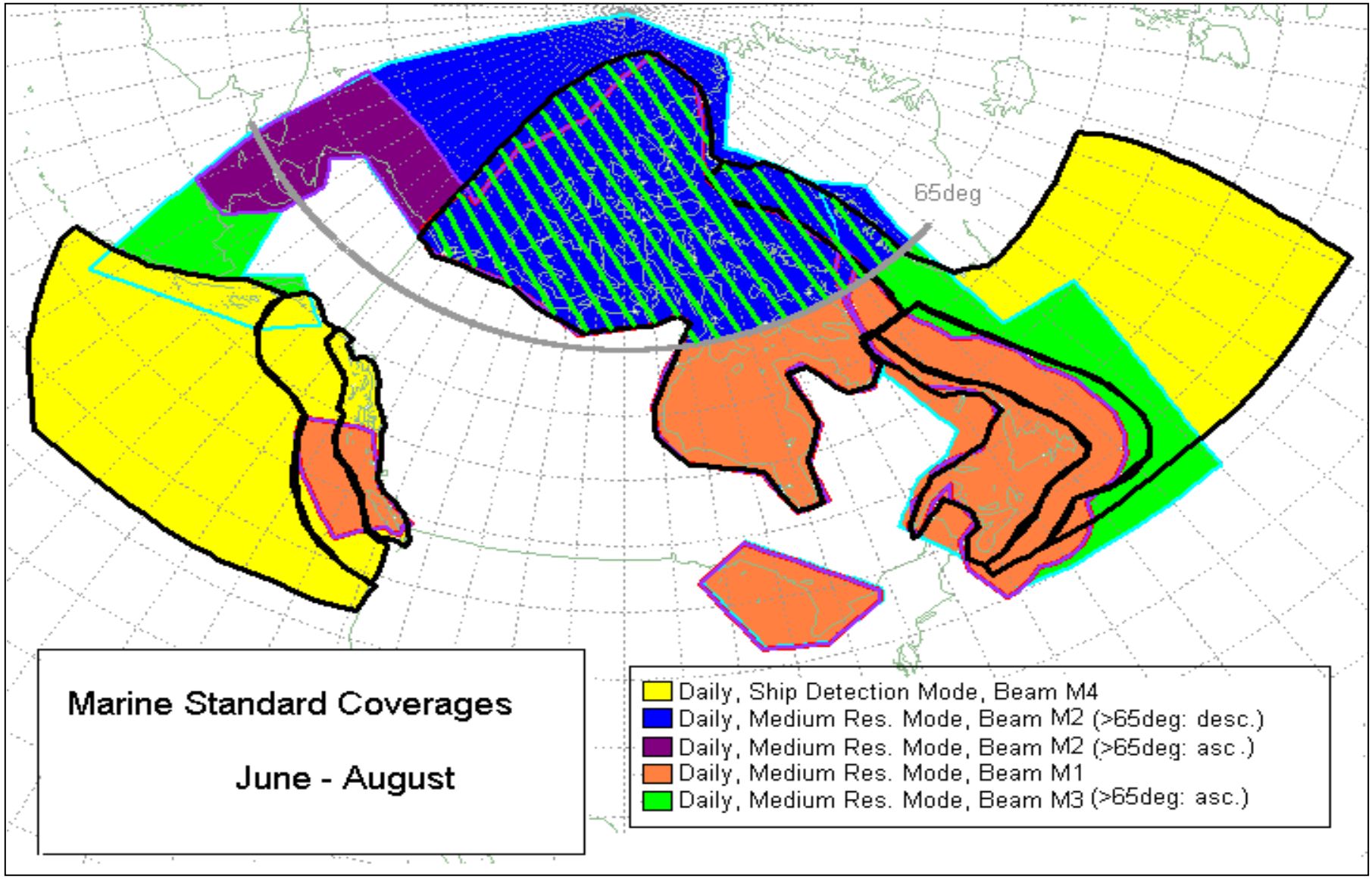
Standard Coverage Concept

- **Issue**
  - Large geographic and temporal overlaps in users and applications requirements
  - Various preferred imaging modes

- **Approach**
  - Analyse user imaging requirements spatially and temporally over the annual cycle to determine a "feasible" imaging plan, with agreed upon compromises in overlapping zones

- **Result → *Standard Coverage***
  - Collections of data acquired routinely in harmonized and de-conflicted imaging modes intended to optimize and maximize the utility of the data across all User requirements

Maritime Surveillance Standard Coverage



Automatic Identification System (AIS)

- An additional payload will be implemented on each satellite to receive AIS signals

Image Products

Raw Products

- Raw Radar data in FRED format

GCC = GeoCoded Complex
GCD = GeoCoded Detected
GRC = Ground range georeferenced Complex
GRD = Ground range georeferenced Detected

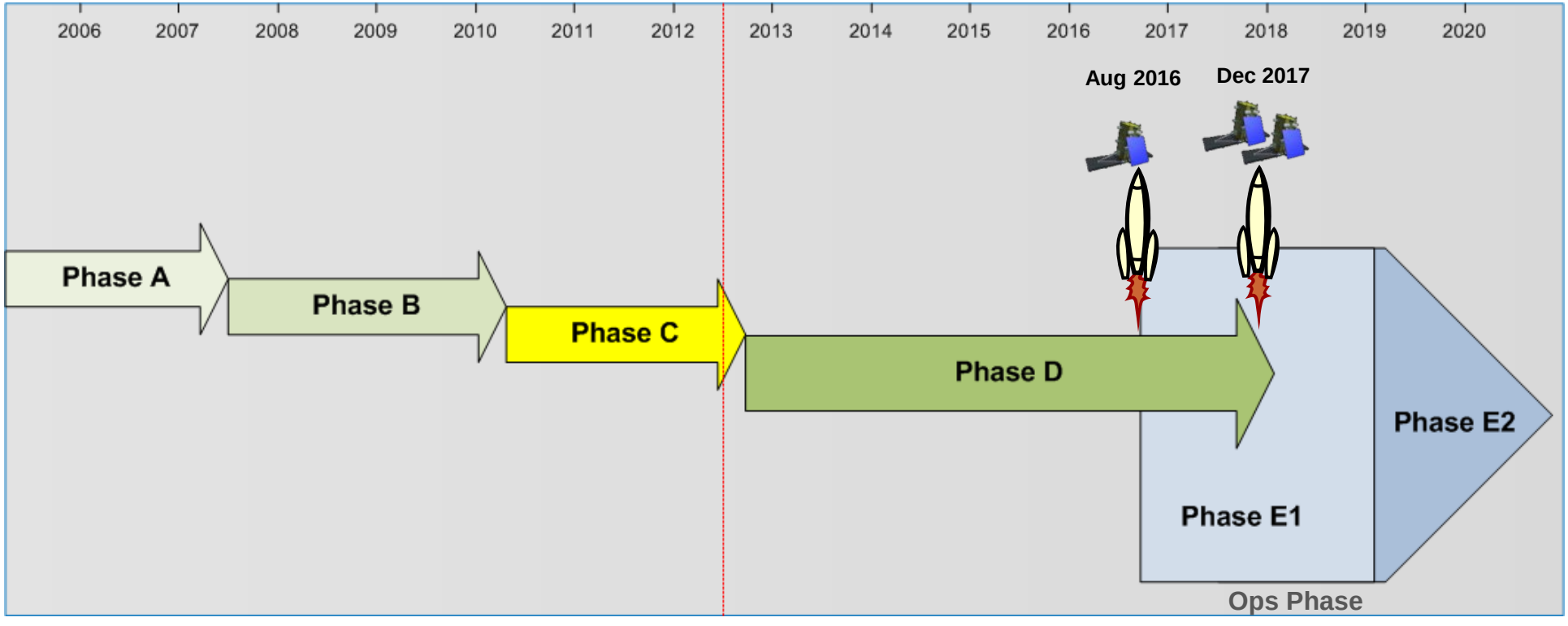
Image Products

- Variety of processing levels
  - ✓ single-look complex products (SLC)
  - ✓ multi-looked power-detected geo-referenced products (GRD, GRC)
  - ✓ geo-coded products (GCD, GCC)

- Include a “Doppler Grid” with 2 km spacing

- Same formats as RADARSAT-2: GeoTIFF images with XML meta-data + NITF 2.1 format.

Schedule


2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Aug 2016
Dec 2017
Phase A
Phase B
Phase C
Phase D
Phase E1
Phase E2
Ops Phase

RCM Data Policy Objectives

- Priority access for Canadian operational users over Canada.
- Data freely and openly available to public as much as possible (world-wide trend toward *full and open* data sharing principles).
- Maintain commercial thrust initiated by previous RADARSAT missions as much as possible.
- Enable a level-playing-field for all Canadian value-added service providers and re-invigorate this industry.
- Protect and preserve data in the long-term.
- Comply with the Remote Sensing Space Systems Act and other GoC regulations.

Collaboration Objectives

- CSA-ESA discussions on-going to explore synergies between Sentinel-1 and RCM and a certain level of interoperability between the missions

- RCM – Sentinel-1 collaboration benefits
  - ✓ Improve coverage of areas of interest
  - ✓ reduce latencies
  - ✓ provide complementary data/modes
  - ✓ could alleviate potential data acquisition conflicts

Sentinel-1 / RCM Joint Activities

- The following are being explored:
  - ✓ Joint / integrated pre-defined observation plans (complementarities in observations / modes, increased revisit)
  - ✓ Level 1 Product format
  - ✓ Harmonisation of catalogue interface
  - ✓ Development of common tools
  - ✓ Harmonised communication, joint publications

- A joint calibration working group has been set up

Thank You!

For more detail on missions

CSA – www.asc-csa.gc.ca

Questions to RCM Mission Manager

RCM: steve.iris@asc-csa.gc.ca