



CSA Report on Earth Observation

**Presented at
CEOS WGCV 30th Plenary
Ilhabela, SP, Brazil
May 26 – 29, 2009**

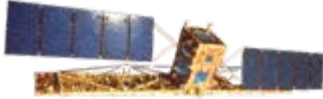
**Dr. Satish Srivastava
CSA Member of WGCV
Canadian Space Agency**



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Canadian Space
Agency

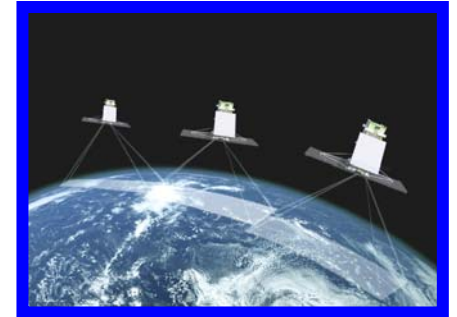
CSA Committed to Provide RADARSAT Data Continuity



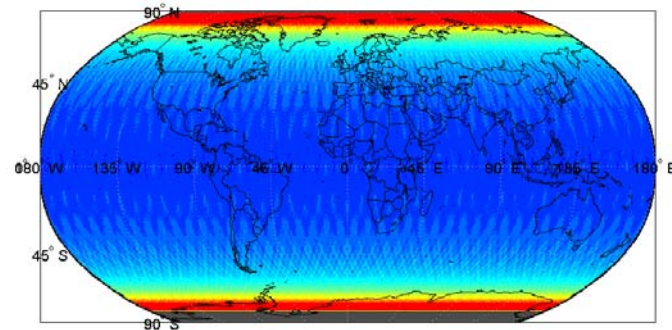
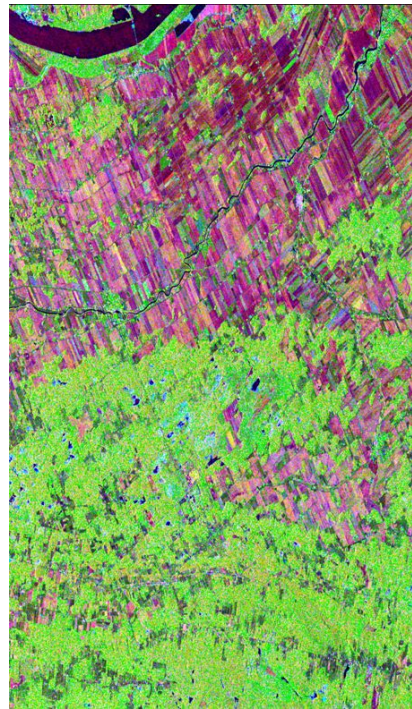
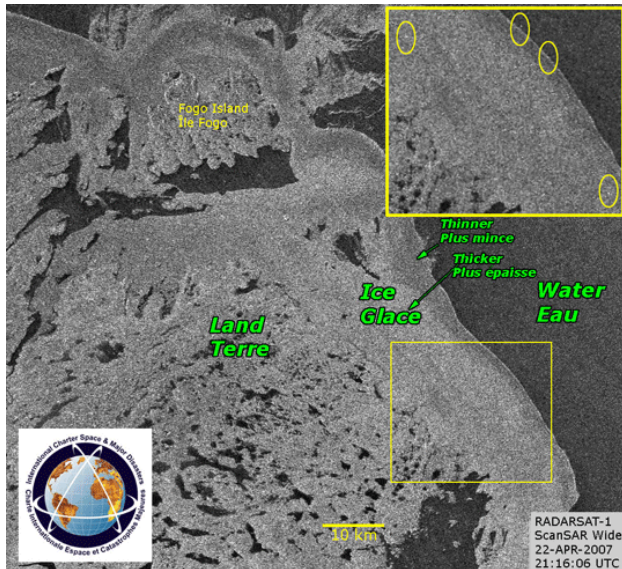
1995: RADARSAT-1



2007: RADARSAT-2

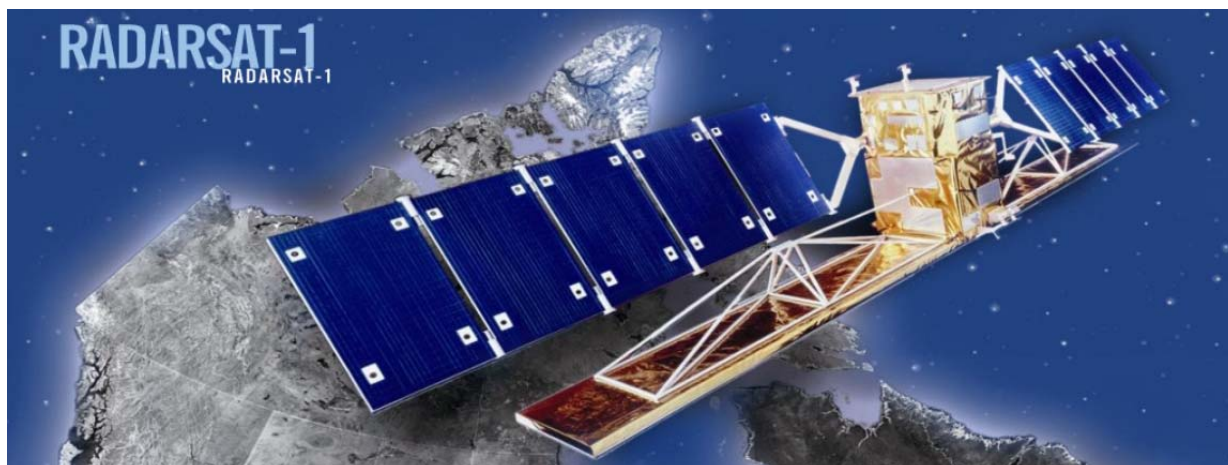


2014:
2015:
2016: **RCM**

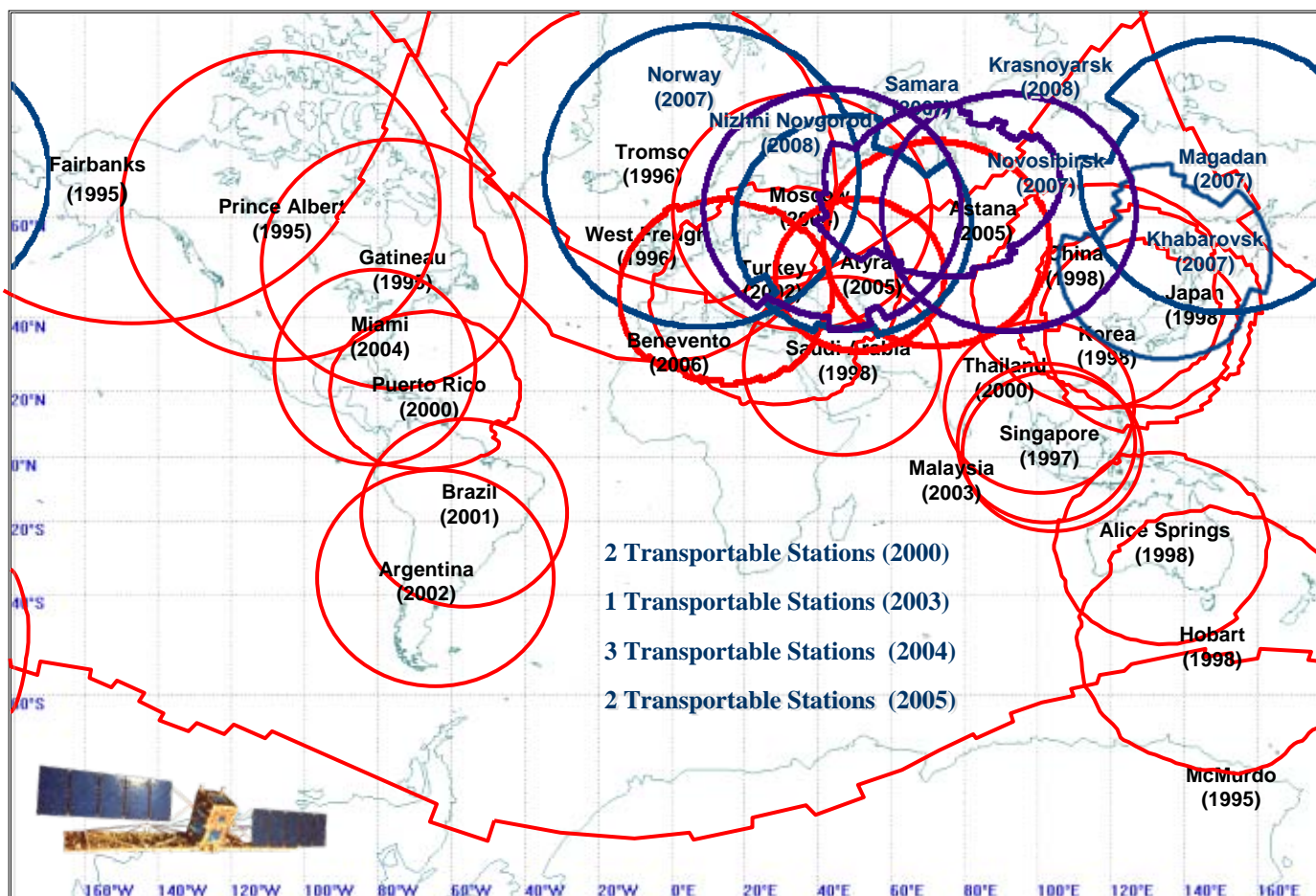


RADARSAT-1 Program Status (1)

- Recently CSA has approved continuation of RADARSAT-1 operation for three more years (until March 31, 2012)
- Running in 14th year of operation
- Data received and processed at 40 ground stations with 28 archive facilities globally. One ground station is presently under certification.
- As of April 27 2009, completed 70,361 orbits, planned 320,580 user requests corresponding to a total acquisition of 611,639 minutes of SAR data
- Average system performance maintained better than 95%



CEOS RADARSAT-1 Reception Coverage



➤ Data Reception Facilities: 40 (including 8 transportable stations)

➤ Data Archive Facilities: 28

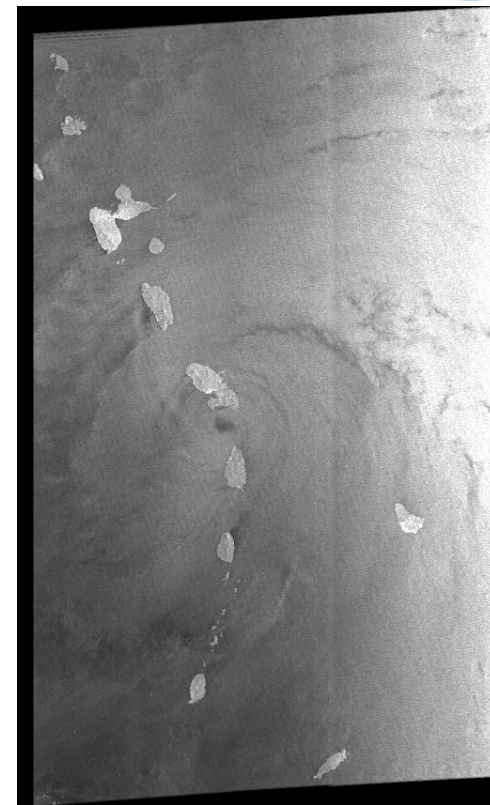
➤ Actually under certification: 1



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- In January 2009 On Board Recorder (OBR) started showing severe degradation in performance resulting in data drop outs and processing failures and thus recoded data was not considered reliable. As a result, OBR utilization was terminated by CSA on February 20, 2009. However, many Network Stations are available globally to receive and process data for clients.
- As a member of International Charter Space and Major Disasters, provided **559 frames of RADARSAT-1 image data** for **212** Charter emergencies to date
- Image quality and calibration maintained better than system specification
- Plans for Background Mission: Multiple coverage campaigns (using RADARSAT-1 and -2);
 - Focus on site and application-specific acquisitions:
 - Natural Hazards
 - Disaster Watch
 - Hurricane Watch
 - Polar Regions
 - 4-Season coverage of Arctic Basin



Hurricane Dean 17 Aug 2007, 09:53 UTC, Lesser Antilles, Caribbean

➤ Data Access:

- CSA is planning to
 - process archives by theme
 - make processed data available online (registered in GEO)
- International Polar Year dataset available on Arctictnet
- EO Products and Services for Arctic Coastal Users (MORSE) to come
- RASTER: Radar Applications for Sensitive Treed Ecosystem Regions to come



- ☐ Launched: December 14, 2007
- ☐ Operational: April 25, 2008
- ☐ MDA commercial operation
- ☐ Provide data to Canadian Government on a pre-purchase agreement basis
- ☐ Ensure data availability for environmental monitoring and resource management

☐ Some CSA allocation can be used for international R&D and Science

☐ CDN\$ 100 M of CSA allocation can be used for bartering

☐ MDA is willing to consider making data available for public good as long as there is no conflict with commercialization

☐ RADARSAT-2 Images shown here are by courtesy of MDA/GSI

- High resolution:
 - 3 m
 - multi-look 10 m
 - SpotLight
- Polarimetric modes
 - single/dual polarization
 - quad-pol
- Right and left-looking capability
- Enhanced ground system providing:
 - efficient satellite tasking (12 - 24 hours routine)
 - faster data processing
 - data encryption

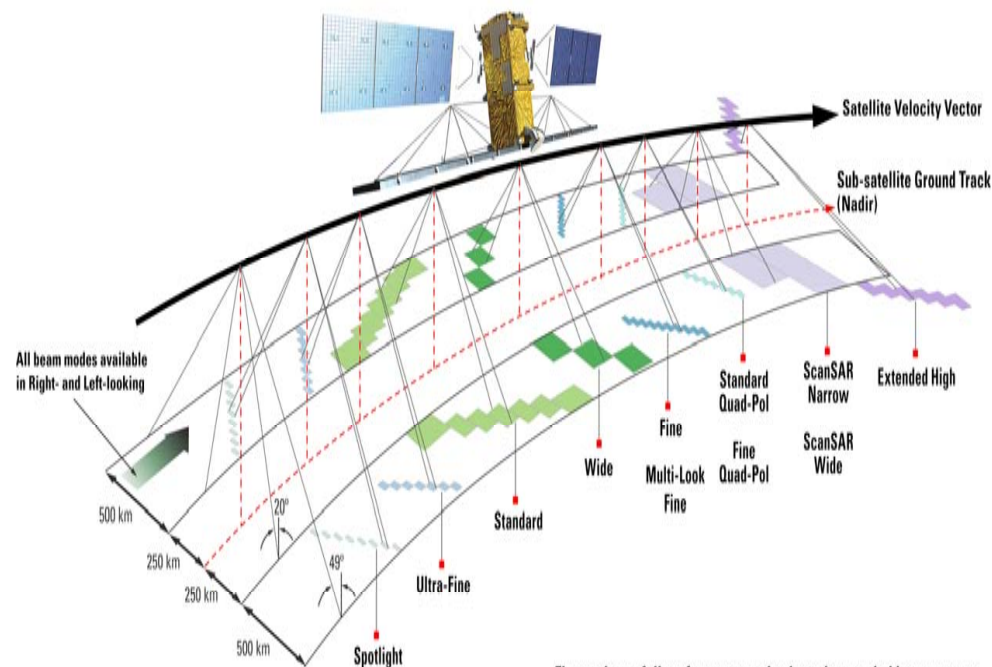
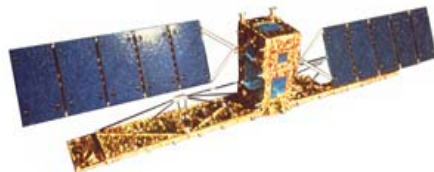


Figure shows full performance and selected expanded beam ranges

AN 4760-91C(11)



RADARSAT-1

RADARSAT-2

Mass at Launch

2750 kg

2280 kg

Design Life

5 years

7 years

On-board Recording

Tape recorder

Solid-state recorder

Spacecraft Location

S/C ranging

GPS on-board

Imaging Frequency

C-Band, 5.3 GHz

C-Band, 5.405 GHz

Spatial Resolution

10 to 100 metres

1 to 100 metres

Polarization

HH

HH, HV, VV and VH

Look Direction

Right-looking

Routine left-and right-looking

Vancouver, Canada

R-1 Standard

R-1 Fine

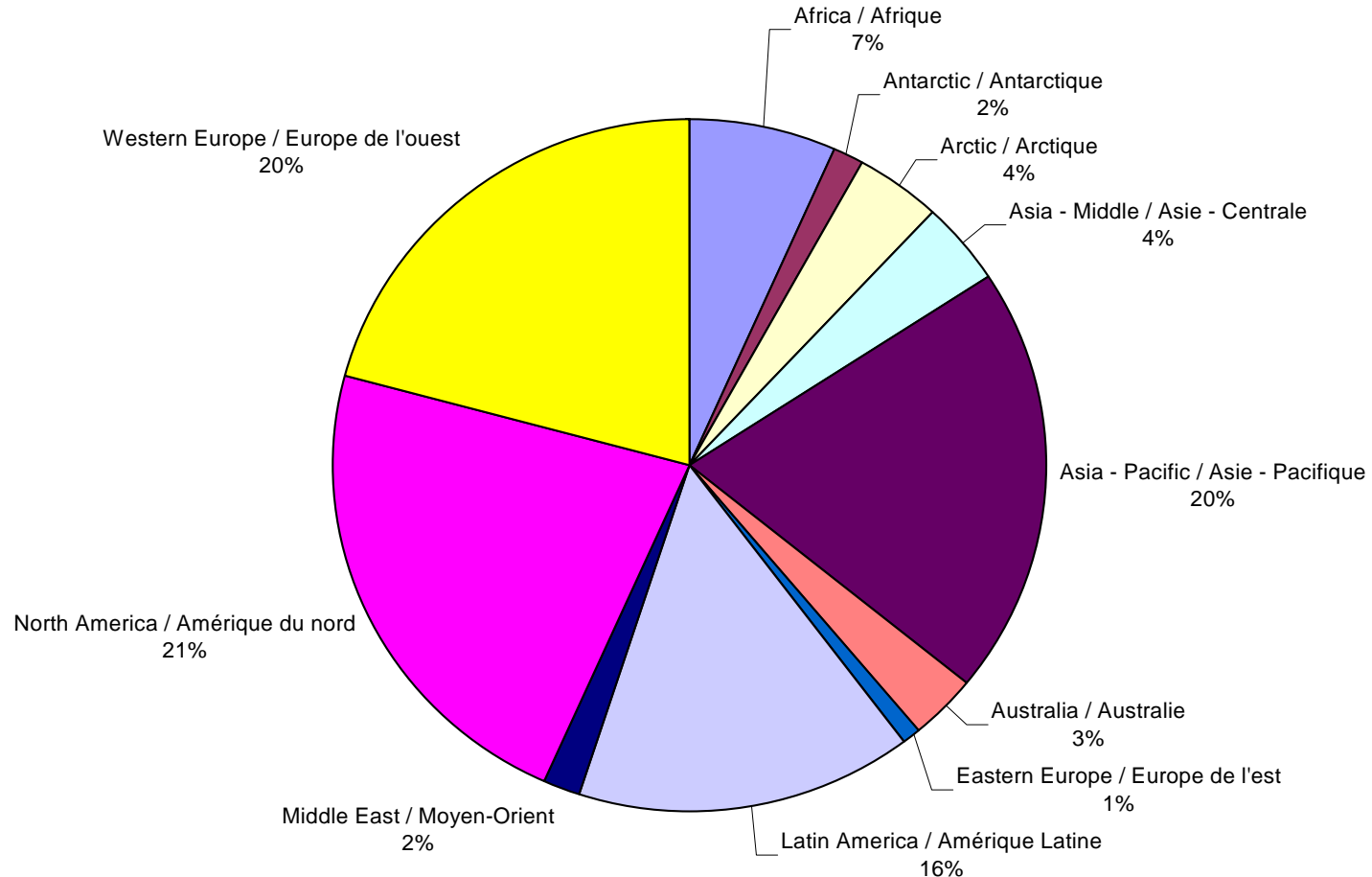
R-2 Ultra-Fine

R-2 Spot Light

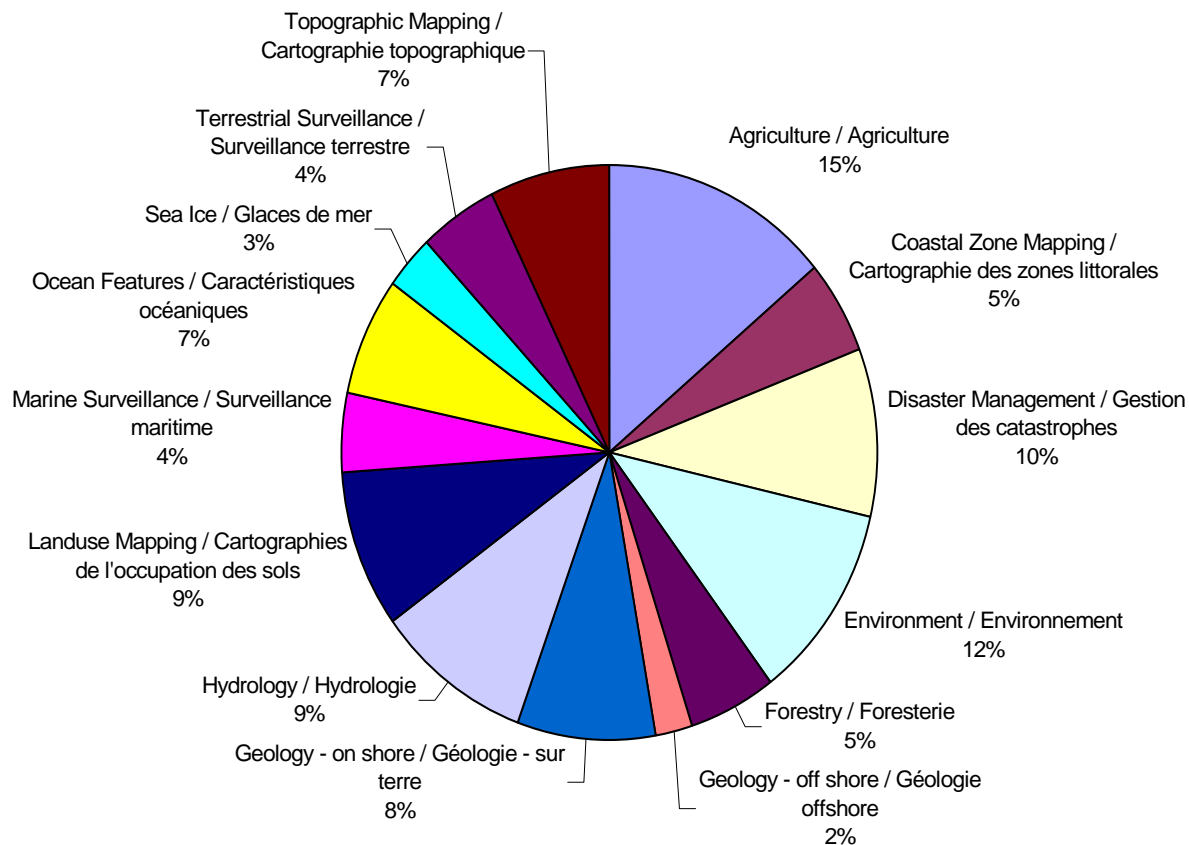
Image Quality Status

- All imaging modes are available for operational use
- Geo-location accuracy for all single beam modes is better than 50m
- Dual-Pol
 - All these modes are radiometrically calibrated for both left- and right-looking imaging
 - All impulse response measures (including resolution) are better than specification
 - The noise floor is several dB lower than for equivalent RADARSAT-1 modes
 - ScanSAR images essentially free of visible beam boundaries and “scalloping”
- Quad-Pol
 - Channel registration checks consistently show registration to better than 1% of a pixel in each dimension after correction
 - Largest cross-pol leakage term (after correction) $< -35\text{dB}$
 - Relative inter-channel phase error after correction $< 4^\circ$
 - Relative inter-channel amplitude error after correction $< 0.4\text{dB}$

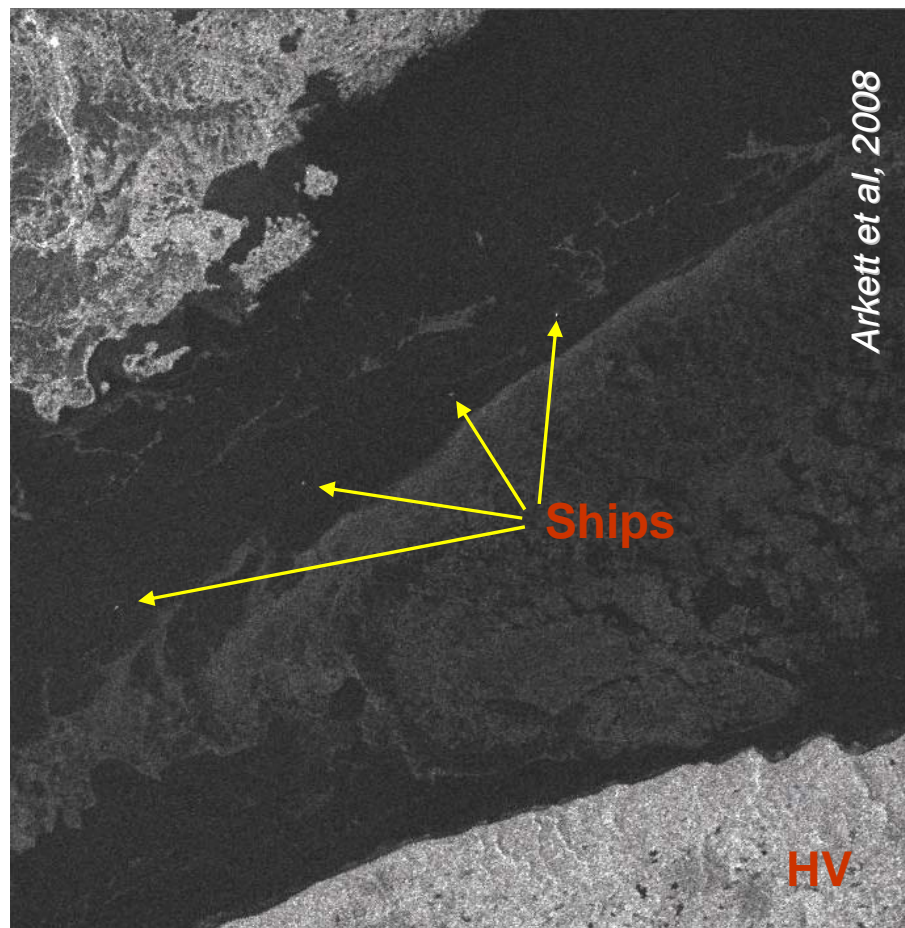
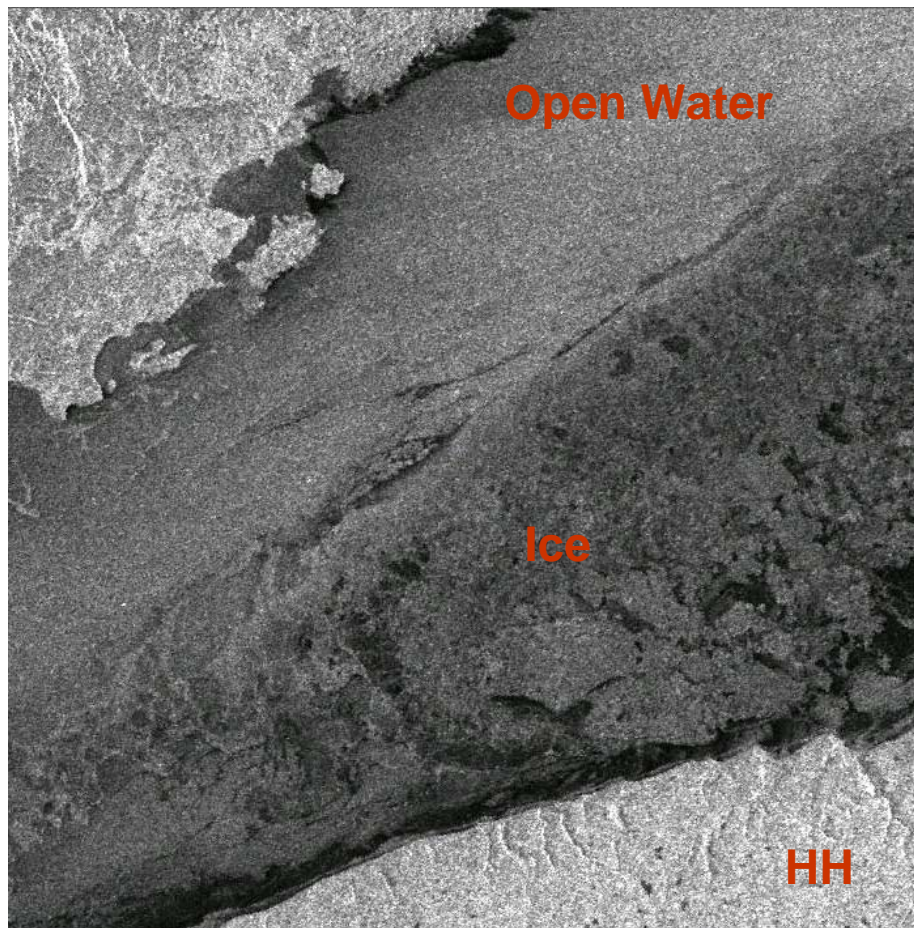
CSA and MDA SOAR Projects – Geographic Distribution



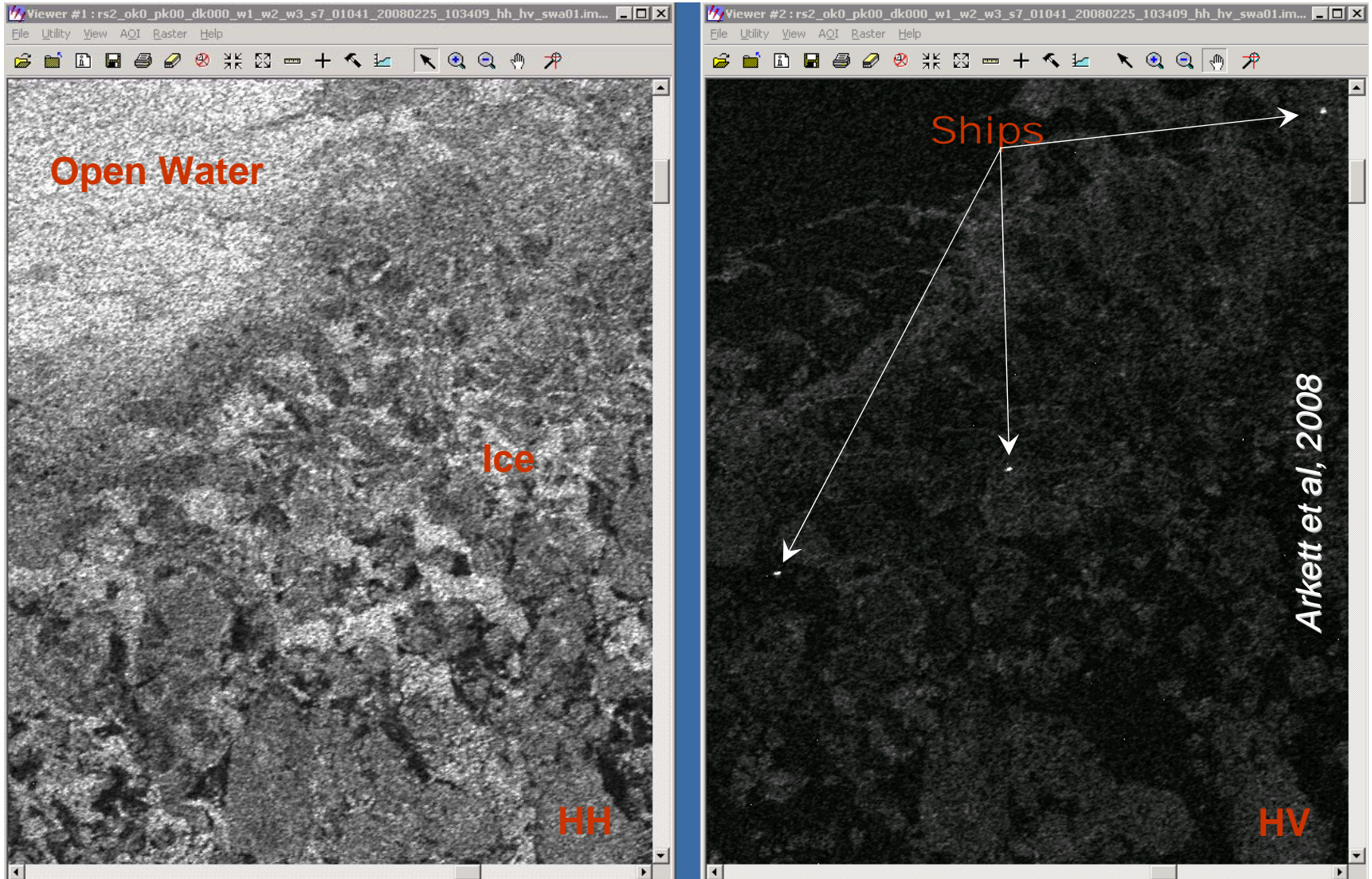
CSA and MDA Projects – Application Distribution

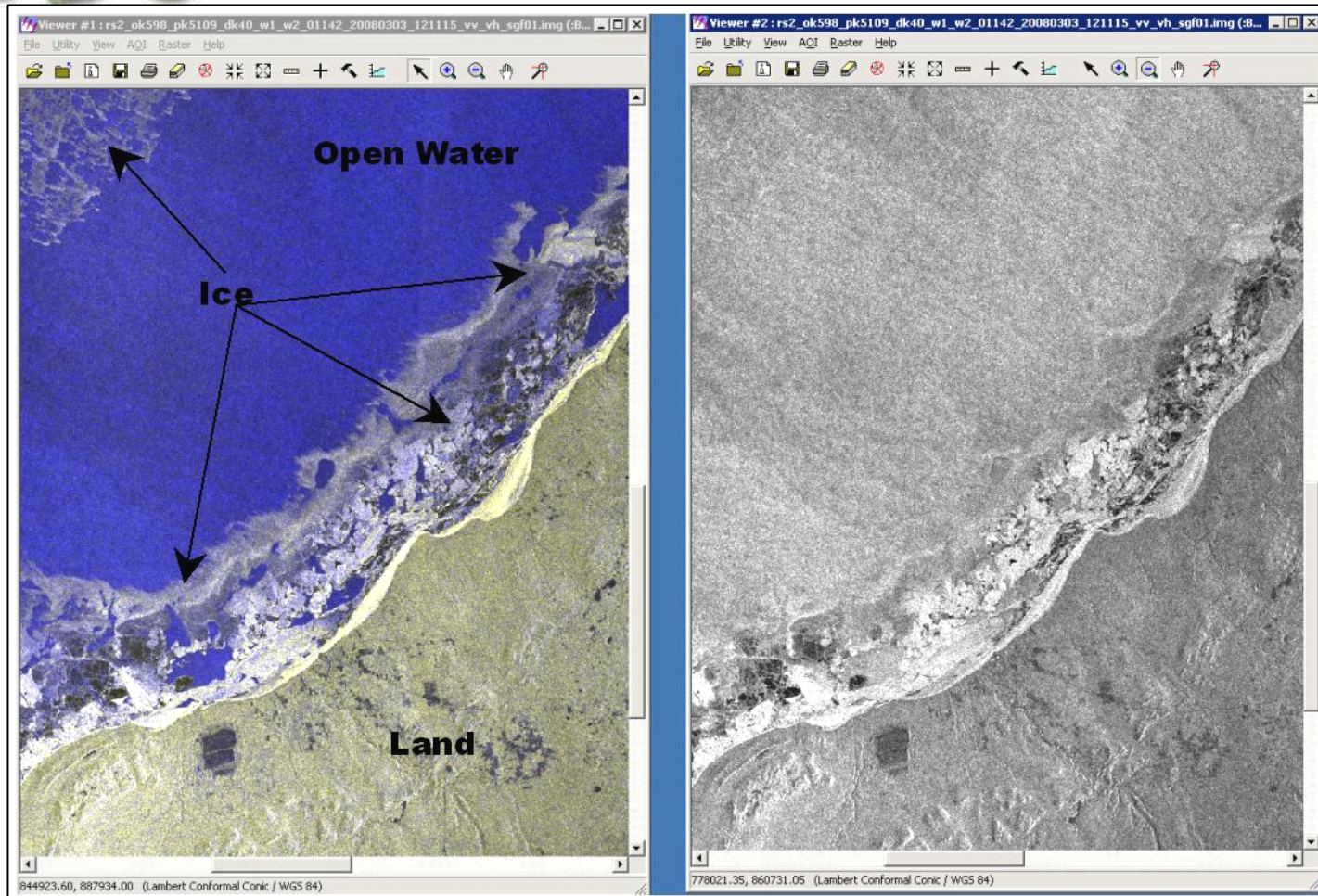


Ice / Water Discrimination

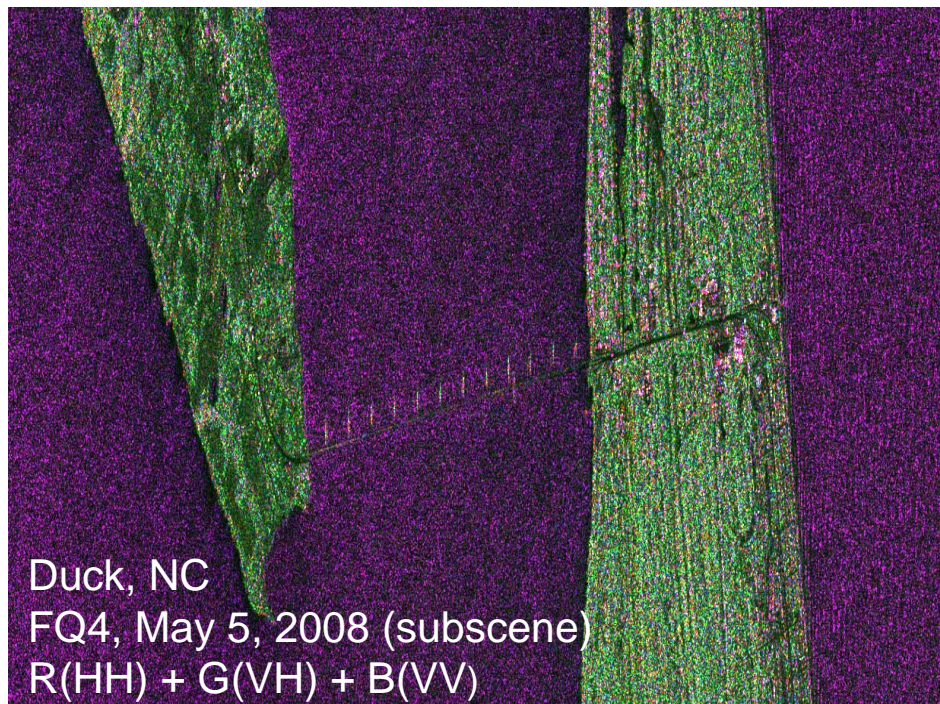
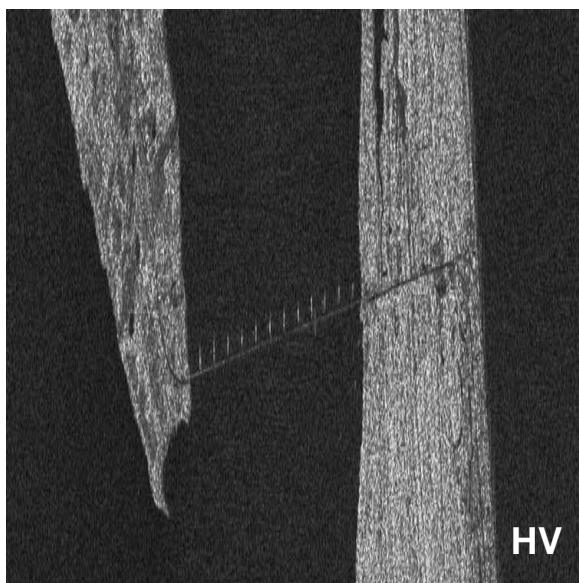
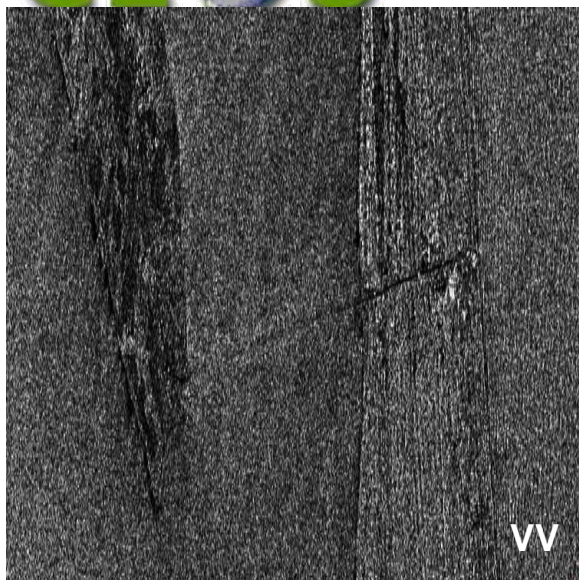


Ship Detection in Ice





Subarea of a RADARSAT-2 ScanSAR Narrow VV/VH image of Lake Superior. *Flett and De Abreu, ASTRO'08.*
The VV/VH image provides improved ice-water discrimination versus the VV image.



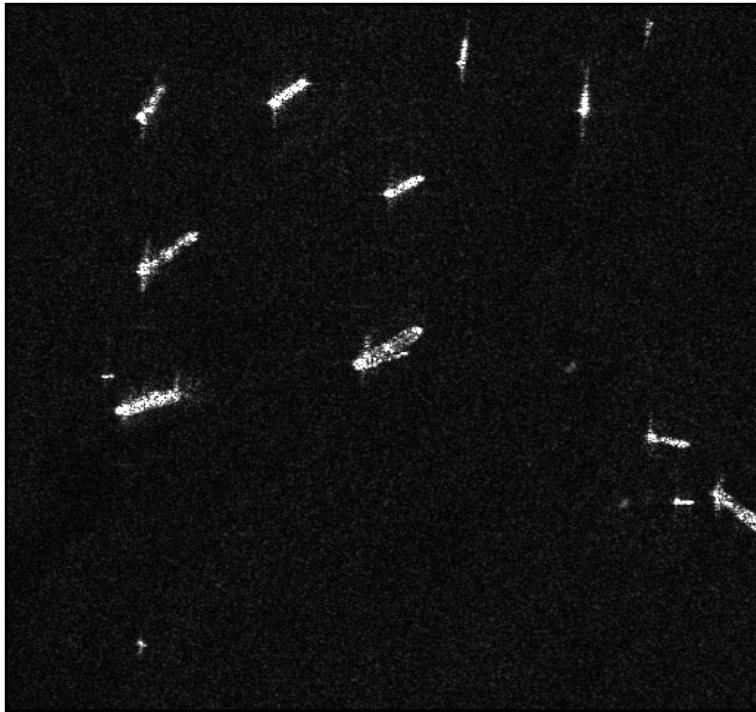
VV polarization provides ocean surface information.
HV polarization provides good discrimination between
surface (ocean) and volume scattering (land).



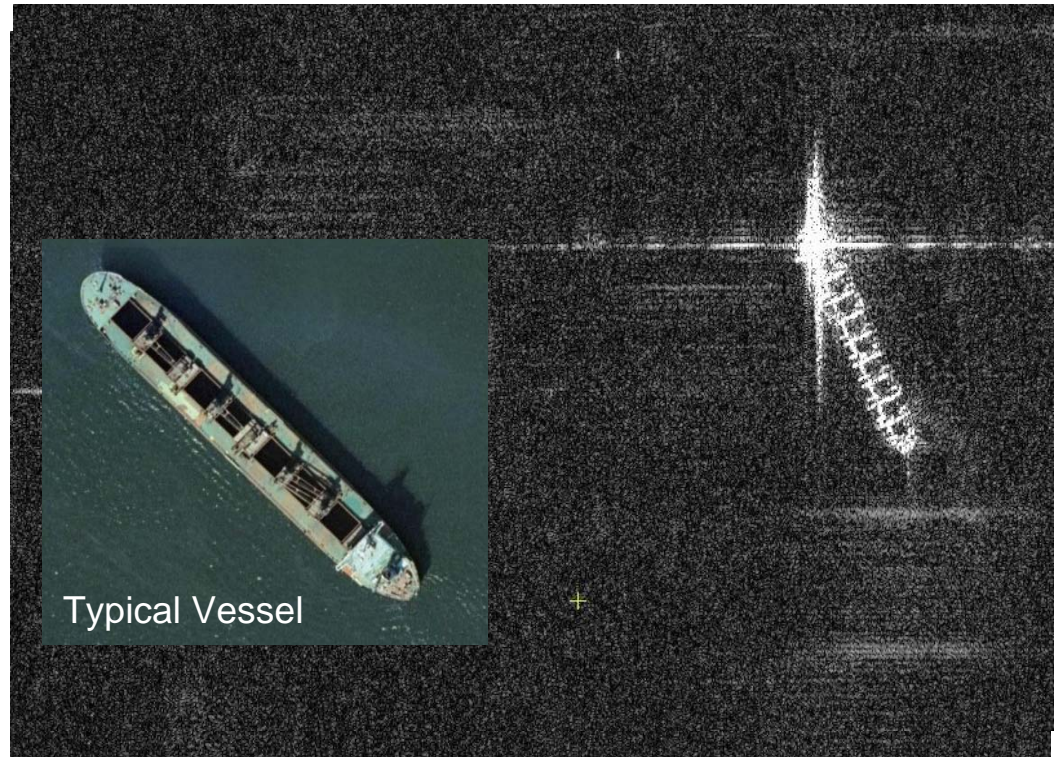
RADARSAT-1 Fine HH



RADARSAT-2 Quad-Pol Fine



RADARSAT-1 Fine
January 8, 1996
Singapore harbour



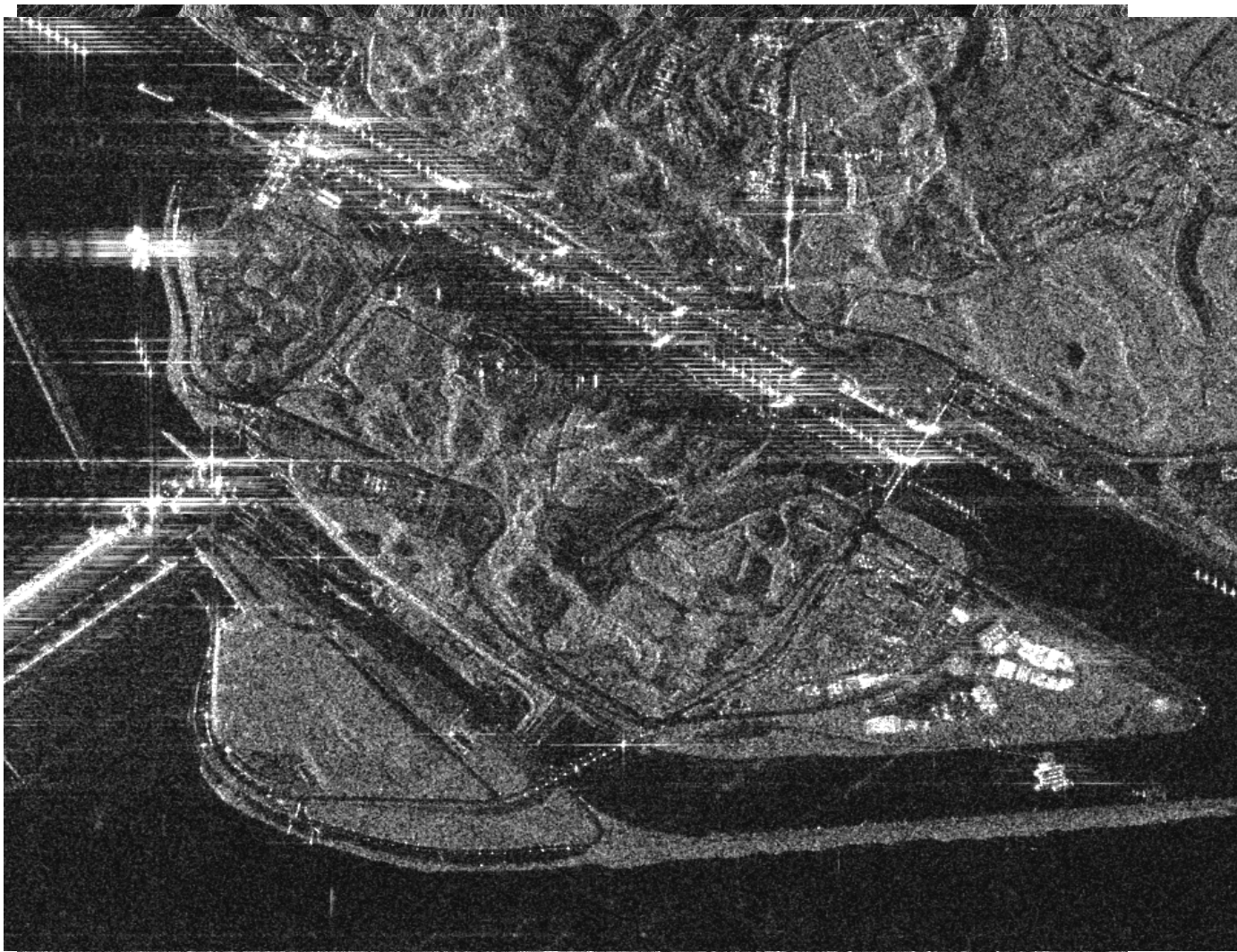
RADARSAT-2 UltraFine, January 8, 2008
Vancouver harbour



Sirius Star
RADARSAT-2 Spotlight
 Dec 19, 2008 15:09:45 UTC



Dam Good Imagery



R(HH) + G(HV) + B(VV)

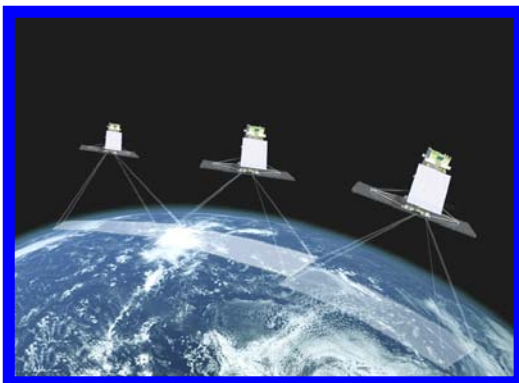


San Francisco
Fine Quad 9
April 2008



28° nominal incidence
angle

12 m (rg x az) nominal
resolution



MARITIME SURVEILLANCE

Ice and iceberg monitoring
Marine winds
Oil pollution monitoring
Ship detection

DISASTER MANAGEMENT

Mitigation
Warning
Response
Recovery and assessment

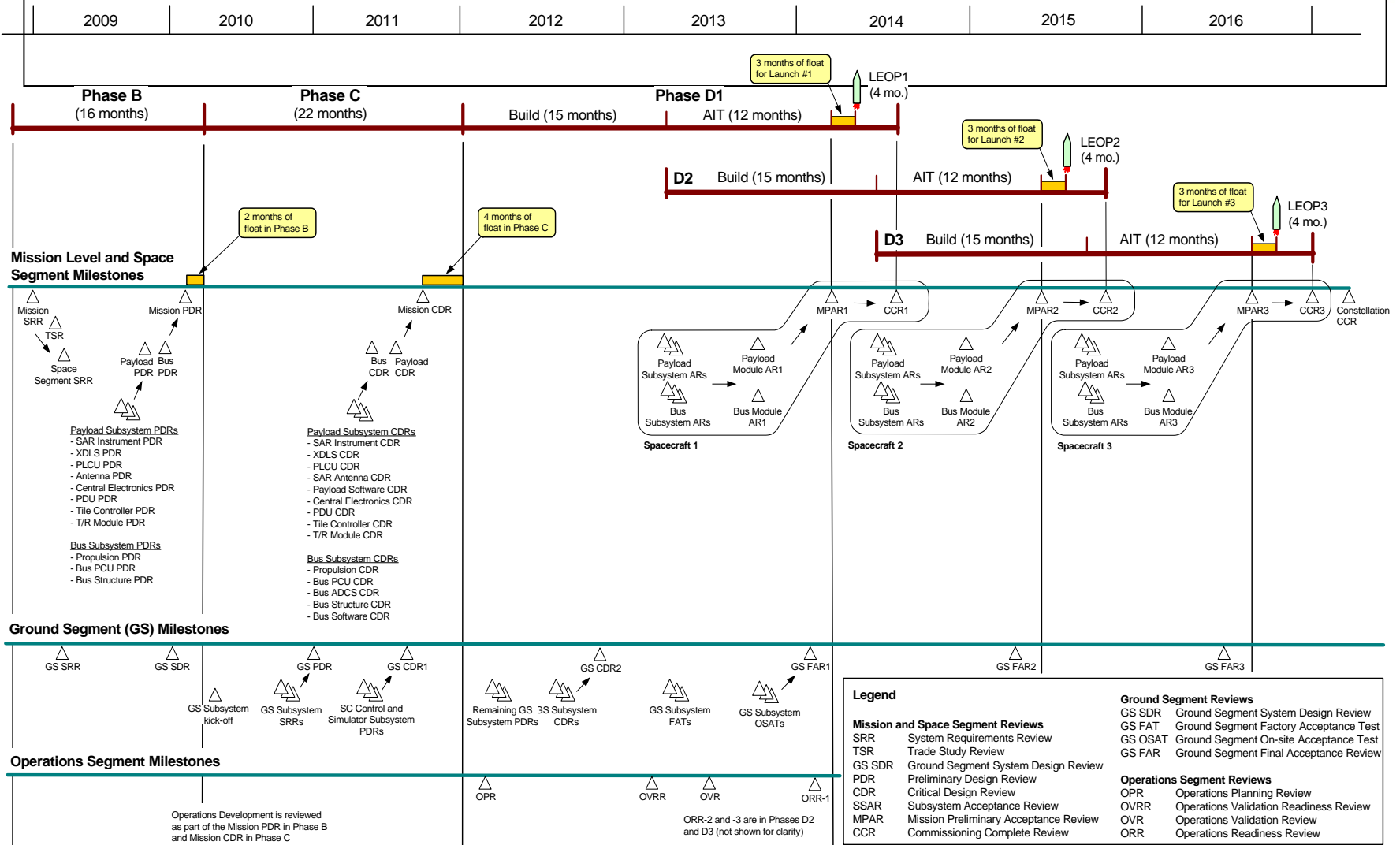
ECOSYSTEM MONITORING

Forestry
Wildlife habitat
Agriculture
Wetlands
Coastal change

- Follow on to the RADARSAT-2 program
- Evolution toward wider operational use and higher reliability
- Provide increased coverage with daily revisit of Canada and daily access to 90% of the world
- Canadian Government owned and operated

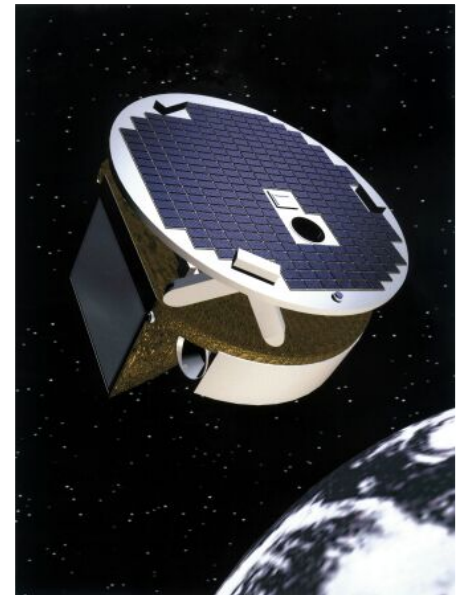
- Three satellites with a potential of six
- Minimum daily coverage of Canadian waters and regular land coverage
- Data analyzed in near real time for operational applications
- 4-day Coherent Change Detection using SAR interferometry in between satellite
- Dual polarization data capability, with experimental quad pol

RCM Master Schedule



SCISAT Program Status (1)

- Launched in August 2003, SCISAT satellite measures numerous trace gases, thin clouds and aerosols in the stratosphere, thereby enabling a more comprehensive understanding of the several chemical processes that play a role in stratospheric ozone depletion
- Recently CSA has approved continuation of SCISAT operation for three more years (until March 31, 2012)



SCISAT

SCISAT Program Status (2)

- Capacity to receive science data was augmented from 1.1 GB (GBytes) to 2.9 GB per day by employing two Canadian stations and those of US and European partners
- In last fiscal year alone, i.e., for the period: Apr. 1, 2008 – Mar. 31, 2009, amount of science data collected was more than 950 GB
- Data routinely being provided to the science team. Intensive data analyses by scientists have produced a number of new results that have been disseminated at international scientific conferences and through the publication of peer-reviewed scientific papers