

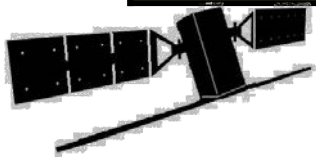
CSA Report on Earth Observation

Presented at
CEOS WGCV 38th Plenary
College Park, MD, USA
Sep 30th to Oct 2nd, 2014

Dr. Satish K. Srivastava
WGCV Chair &
CSA Member of WGCV
Canadian Space Agency

Spacecraft Health and Anomalies

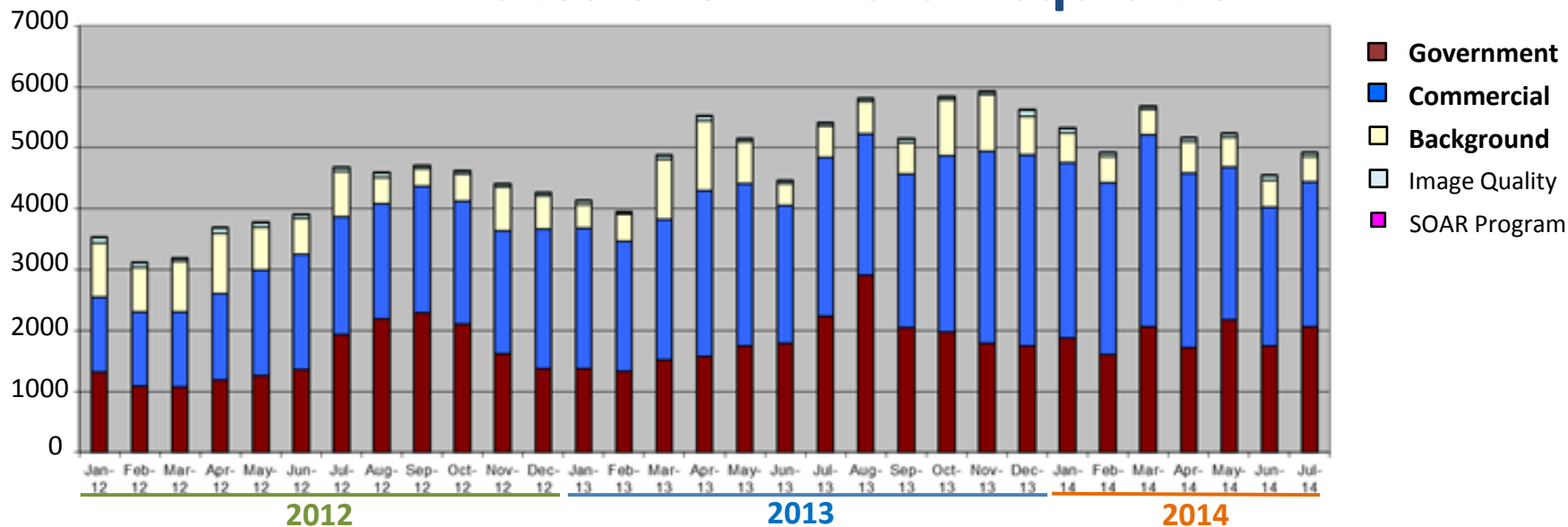
System	Status
Thermal	About 4°C increase in 5.5 years. Heater on Reaction Control Thruster #3 Fuel Control Valve show intermittent failures, now using redundant heater group. A few monitoring sensors failed with no impact.
Power	Battery and Solar array: No sign of degradation Following 2014 Eclipse period, Solar Array were kept in Sun tracking mode (Vs previous default of Body Aligned) to reduce stress on battery from multiple charge cycles causes by higher SAR demand.
AOCS	Attitude and orbit well within specifications. Now using gyro 2, 3 and 4 as gyro 1 showing aging sign.
Propulsion	Well within specifications. Fuel margin greater than expected
Data Handling	Well within specifications. All systems nominal.
Payload	Two Hardware failures (CDU#12 and CDU#3 heater). Finalizing mitigation strategy should CDU#12 redundant side also fail.



Many Bus and Payload anomalies related to Single Event Upset.

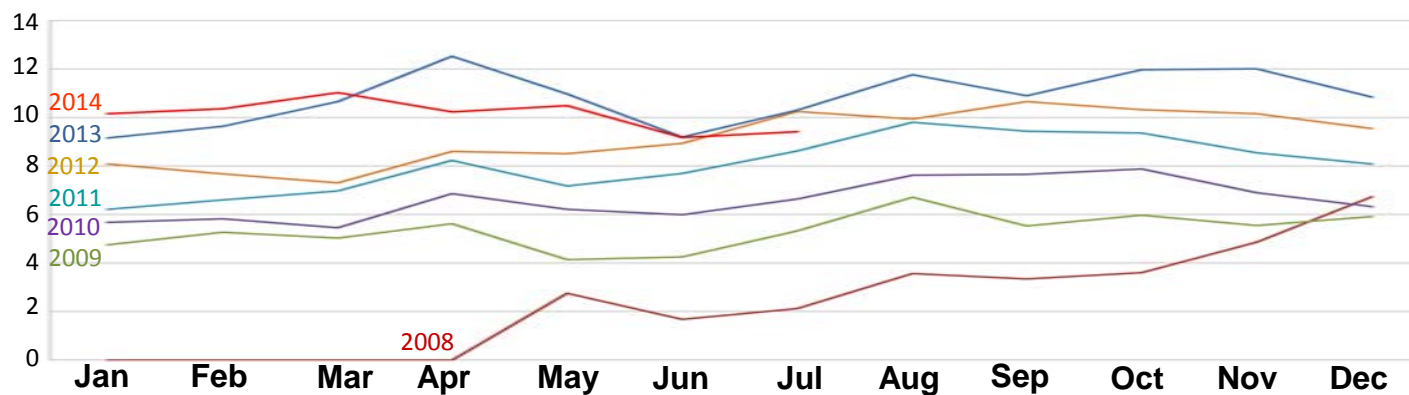
When not SEU related, most anomalies are managed through monitoring and recovery using pre-prepared and, in some cases, automatic recovery procedures.

Minutes of SAR Data Acquisition



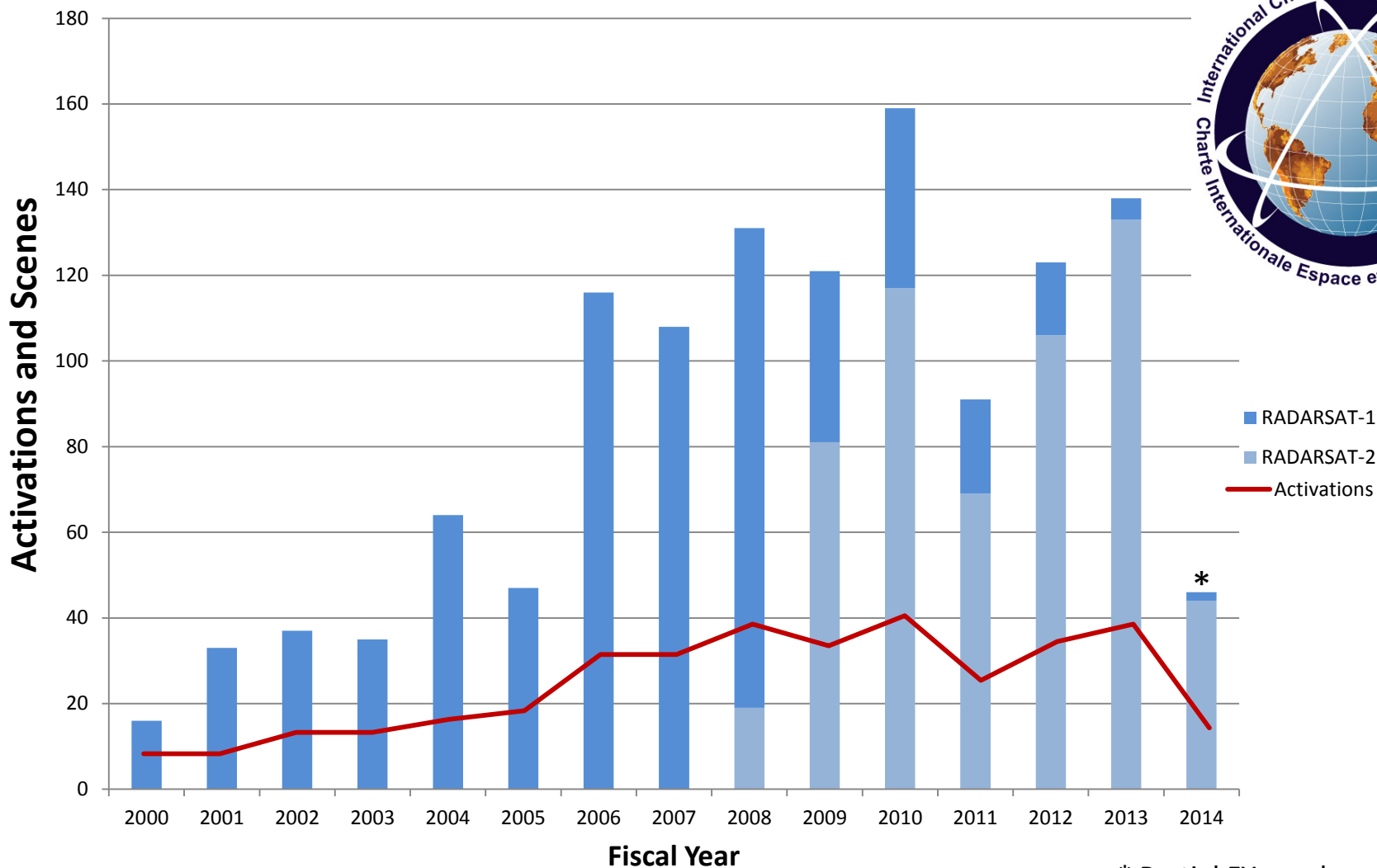
Above figure covers minutes of SAR acquired per main user group for the past 2+ years

Figure below covers the average SAR on time per orbit on a given month to highlight seasonal activities



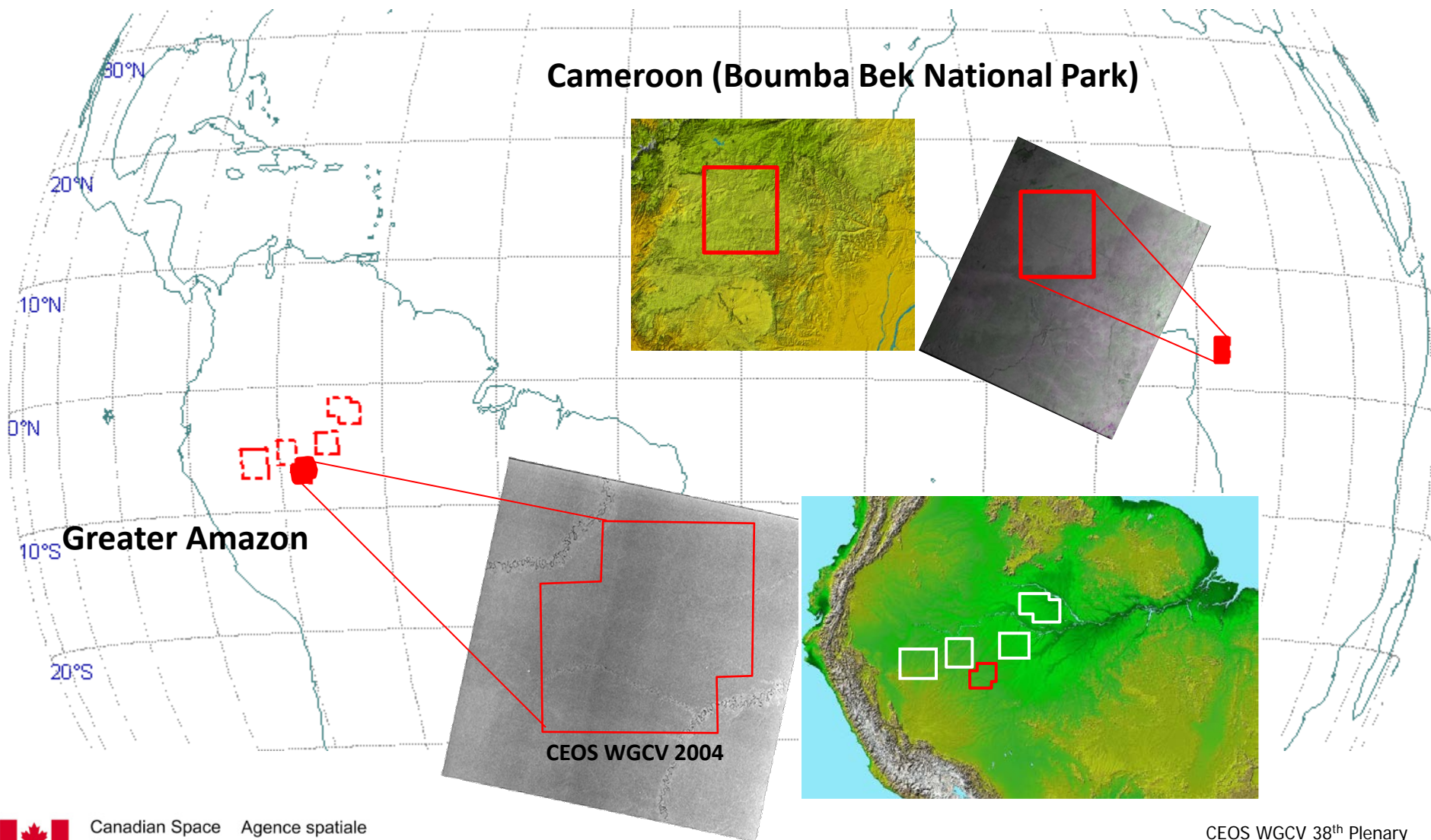
International Charter

R1 and R2 Activations and Scenes, 2000-2014



* Partial FY numbers for 2014

Monitoring of RADARSAT-2 SAR Radiometric Calibration



Natural SAR Cal-Val Sites as Seen by RADARSAT-2

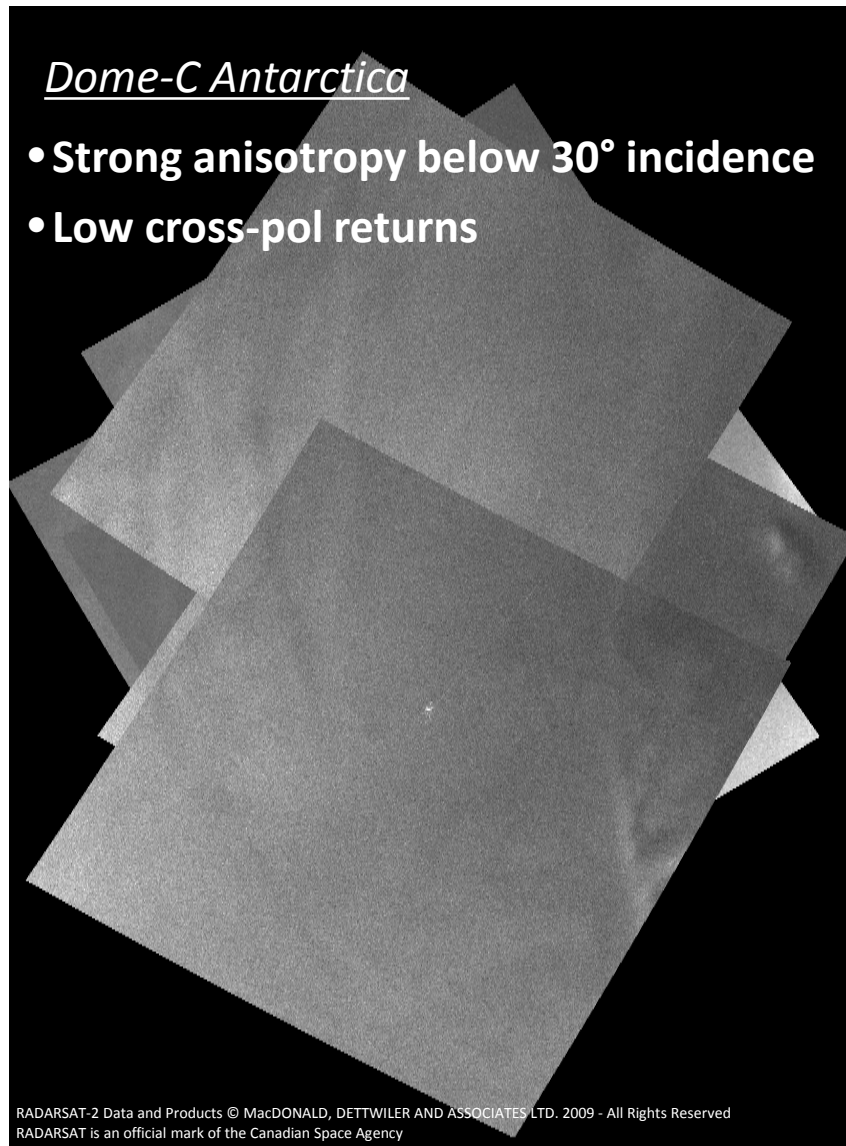
Amazon

- Well characterized (backscatter variation with incidence, backscatter levels, seasonal variations)
- Flat terrain uniform vegetation coverage on a very large scale
- Deforestation nearby exploited areas

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Dome-C Antarctica

- Strong anisotropy below 30° incidence
- Low cross-pol returns



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Cameroon: Boumba Bek National Park

- Backscatter characteristics similar to the Amazon (backscatter variation with incidence, backscatter levels)
- Hilly terrain, less uniform vegetation coverage may affect beam pattern measurements for smaller swaths images

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RADARSAT Point Target Facility at CSA HQ

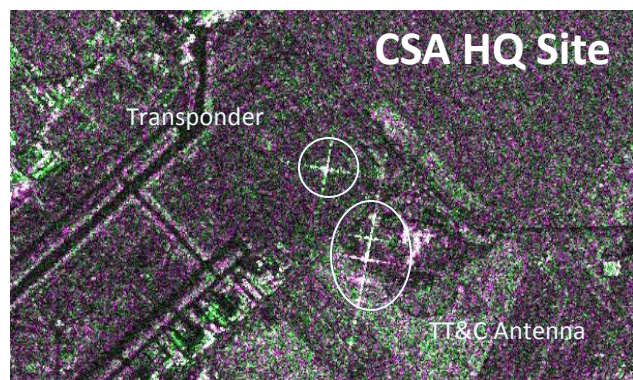


- In operations since spring 2012
- Made from upgraded RADARSAT-1 precision transponder
- For the R2 Quality Assurance mandate of the GoC, operates in conjunction with another upgraded R1 instrument in Ottawa

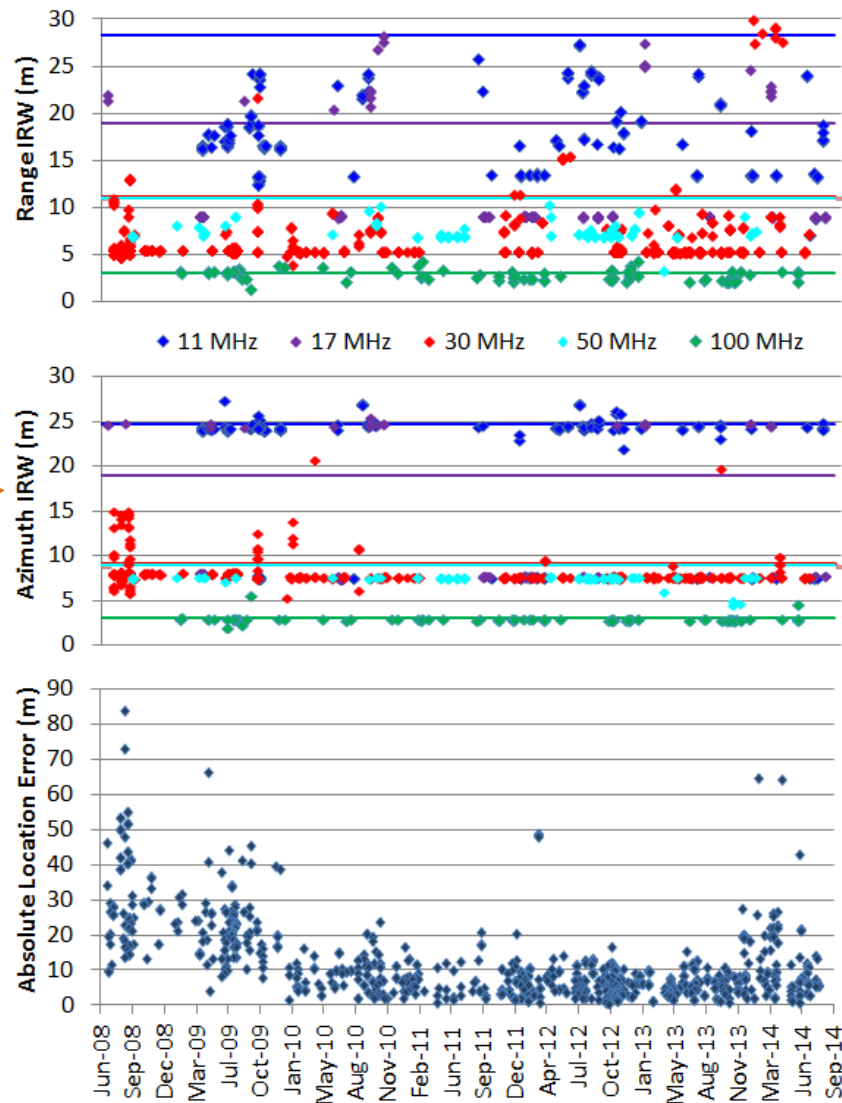
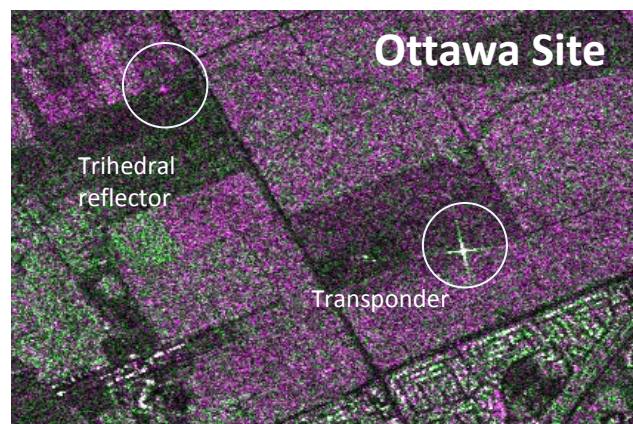


CSA executes the mandate of the Government of Canada to monitor R2 SAR performance

- Excellent overall image quality results: IRW, georeference



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Science and Operational Applications Research (SOAR)

SOAR

SCIENCE AND OPERATIONAL APPLICATIONS
RESEARCH FOR RADARSAT-2



• DATA ACCESS PROGRAM

RADARSAT-2 hosts a number of new capabilities including high-resolution at 3m, fully polarimetric (Quad-Pol) and dual polarisation modes for the RADARSAT-1 "heritage" beams. SOAR provides an opportunity to explore the enhanced capabilities of RADARSAT-2 and their potential contributions to applications, operational requirements, and business opportunities.

WWW.RADARSAT2.INFO

PARTNERS:

- RADARSAT INTERNATIONAL (RSI)
- MACDONALD DETTWILER AND ASSOCIATES INC.
- CANADA CENTRE FOR REMOTE SENSING /
CENTRE CANADIEN DE TÉLÉDÉTECTION

- The SOAR Program offers **access to RADARSAT-2** data for **research and testing**
- The SOAR Program provides an opportunity to **explore the enhanced capabilities of RADARSAT-2** and expand development of applications through the loan of RADARSAT-2 data for research projects.
- The SOAR umbrella Program uses **Announcements of Opportunity** to raise interest and access to RADARSAT-2 data for R&D purposes by stakeholders other than the Government of Canada.
- SOAR is a living, evolving program with new initiatives in response to interest in collaborative efforts on the part of space agencies around the world, and to specific requests from the EO community.
- For more information:
<http://www.asc-csa.gc.ca/eng/programs/soar/default.asp>

The CSA's **Earth Observation** programs, alone or in partnership with national or international organizations, issue announcements of opportunity.

Previous Opportunities

- SOAR-ASI: Joint initiative with ASI: COSMO-SkyMed/ RADARSAT-2
- SOAR-EU-2: Joint initiative with ESA
- SOAR-EI: Education International
- SOAR-DLR: Joint initiative with DLR: RADARSAT-2/TerraSAR-X
- SOAR-EU: Joint initiative with ESA
- SOAR-I: International (Pre-launch)

Scenes requested Scènes demandées	7751
Scenes acquired & delivered Scènes acquises et livrées	3033
Scenes to be acquired Scènes à être acquises	4718

Submitted Projects Projets soumis	508
Accepted Projects Projets acceptés	236
Rejected Projects Projets rejetés	63
Projects cancelled by PI Projets annulés par le IP	14
Projects in evaluation/writing stage Projet en cours d'évaluation/rédaction	9
Closed Projects Projets fermés	186

Current Opportunities

- SOAR-Geohazard (CEOS linked)
- SOAR-AF: Africa
- SOAR-CPT: Canadian Provinces and Territories
- SOAR-E: Education Canada
- SOAR-E G&C
- SOAR-JECAM: (Crop Area monitoring)

Opportunity in Development

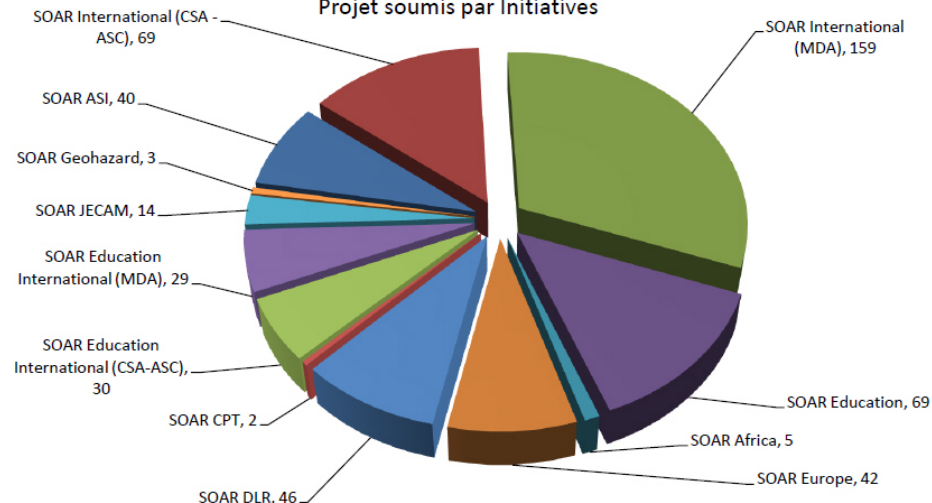
- SOAR-FCT: (Forest Carbon Tracking)

Opportunities in initial negotiation

- Japan - DLR (phase 2)
- India - RCM (Compact Pol)
- Korea

SOAR

Submitted projects per Initiative
Projet soumis par Initiatives



RADARSAT Constellation Mission (RCM)

- Three Satellites
- Design completed – Mission Critical Design Review held in Nov 2012
- Project approved and funded (phase D, launch and operations)
- The Government of Canada will own the RCM satellites and data, and will control data dissemination. CSA is the prime authority for its operation and management.
- Phase D ongoing. All units are in full flight manufacturing as per plan.
- Spacecraft assembly, integration and test plan are being finalized.
- Ground segment system level preliminary design review completed.
- Planned for launch in Q3 2018



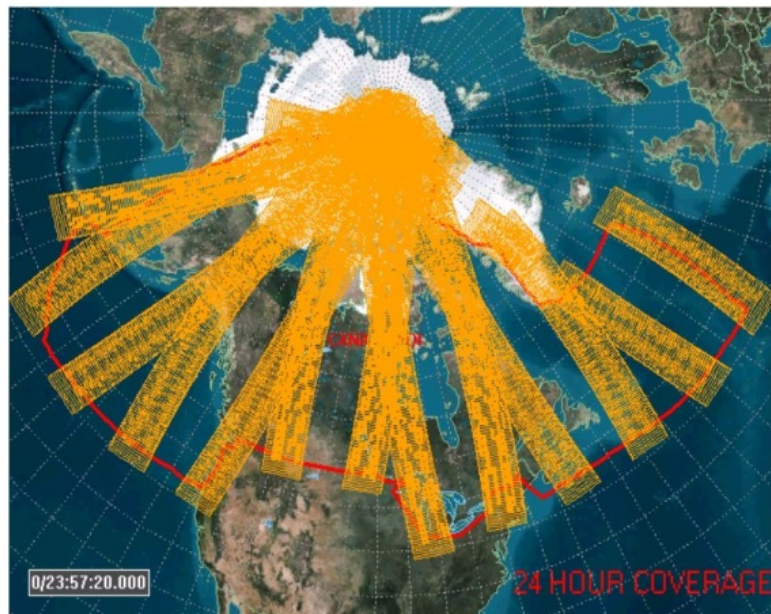
Raw Products

- Raw Radar data in Framed Raw Expanded Data (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); *equivalent to a SLC product for RADARSAT-1 or RADARSAT-2.*
 - multi-looked power-detected geo-referenced products (GRD, GRC); *equivalent to an SGX, SCN or SCW product for RADARSAT-1 or RADARSAT-2.*
 - geo-coded products (GCD, GCC); *equivalent to an SSG or SPG product for RADARSAT-1 or RADARSAT-2.*
- ✓ Includes a “Doppler Grid” with 2 km spacing
- ✓ Same format as RADARSAT-2: GeoTIFF images with XML meta-data + NITF 2.1 format.



**Current coverage with
RADARSAT-2**

- Major gaps in maritime approaches
- Northwest Passage (NWP) coverage also incomplete
- Canadian land mass coverage



**Coverage with
RCM**

- Coverage of NWP up to 4 times daily
- Minor gaps in East and West maritime zones (completed on next day)
- Land mass coverage virtually complete

Data Policy Principles

- **Canadian Interests First**

- *Give priority to GoC requirements in support of sovereignty, security and safety*
- *Fuel prosperity and advance foreign policy objectives*

- **Economic Growth**

- *Strengthen Canadian industry's capacity to commercialize value added application products and services, at home and abroad*

- **Support Partnerships**

- *Enable cooperation with allies/partners to meet socio-economic and security objectives*
- *Support international organizations related to safety, humanitarian programs and other initiatives of benefit to Canadians*

- **Commercial distribution of RCM data**

- *Enable the commercial distribution of RCM data, while being compliant with the Open Government Strategy*

Next Step:

- Baseline Policy currently within internal approval chain
- Initiate work on the Data Policy Implementation Handbook for SAR and AIS data
- Consultation to validate projected utilization of RCM by GoC and other users

- 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.
- CSA has approved continuation of SCISAT operation until March 31, 2015.



SCISAT

- Completed 56,560 orbits.
- Delivering data to the scientific community using stations in Canada (Saskatoon and Saint-Hubert), ESA (Kiruna), DLR (Weilheim), NASA (ASF).
- Science data acquired vs. Planned performance > 96%
- More than 9000 Gbytes of data provided to the science team since launch.
- 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.