Canadian Government Cal/Val Activities: Exploitation and Exploration of Distributed Target Sites within the RADARSAT Program

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Outline

Introduction

Amazon

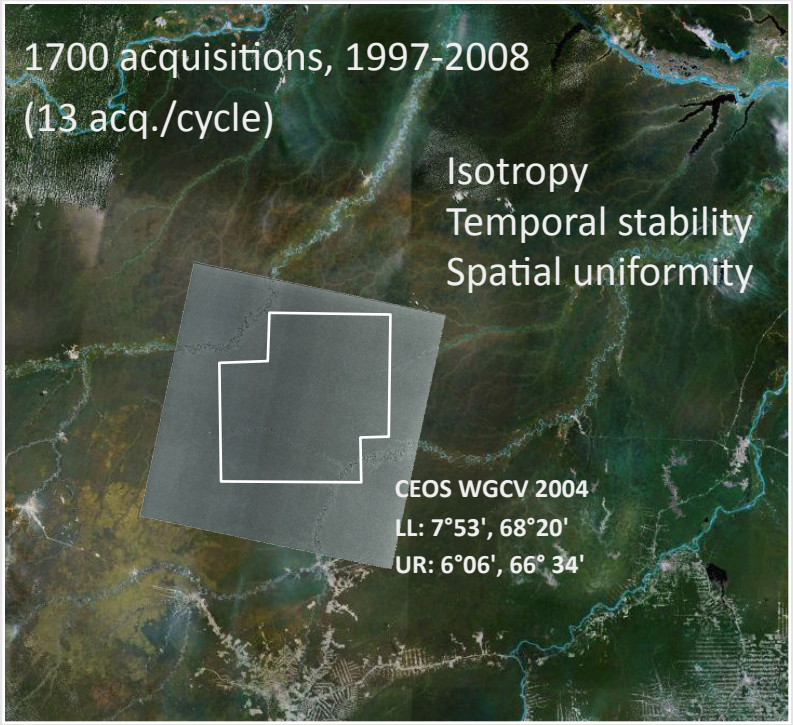
Canadian Boreal Forest

Congo

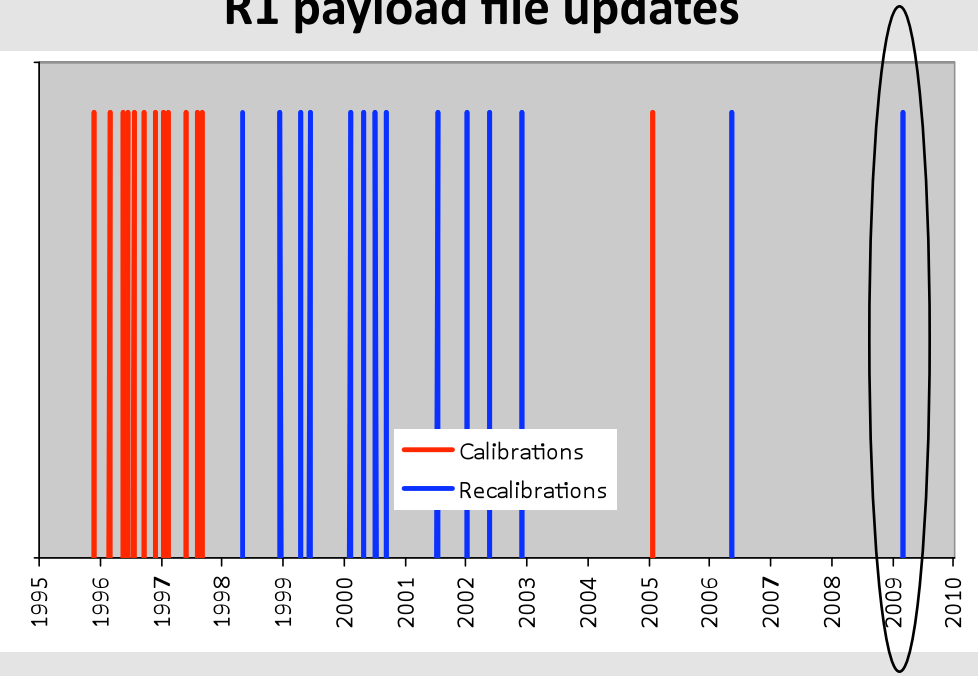
Antarctica

Summary

Use of Amazon for R1



R1 payload file updates



Current reference pattern

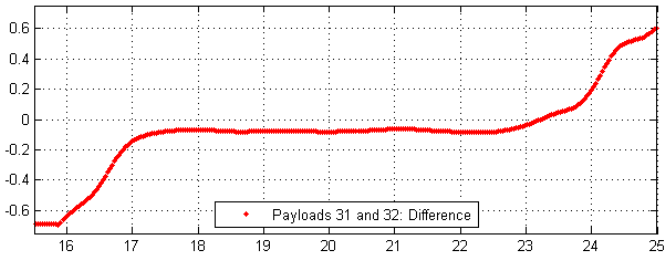
In-orbit measurements of elevation beam pattern
(averaging of image lines)

} **Difference pattern** ⇨ **Radiometric deviation**
(maintained within 1 dB)

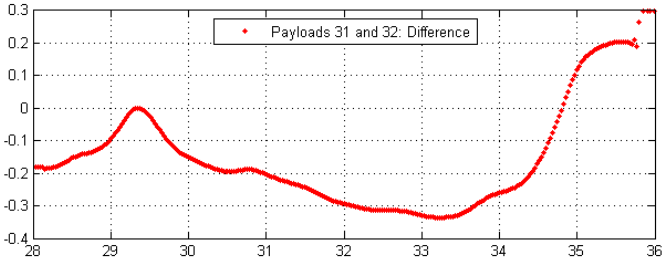
Latest recalibrations were performed in March 2009 on beams F3, S1, S4, EL1, EH3, EH6.

Payload Update 32

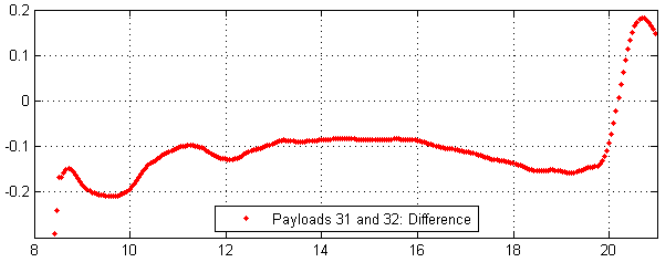
S1



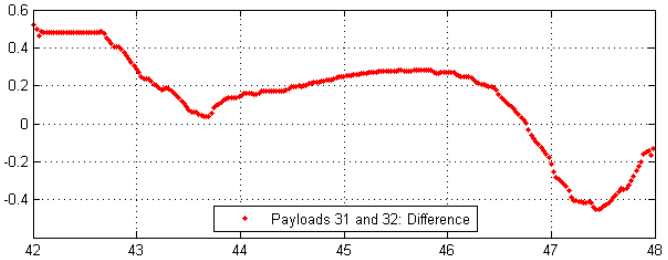
S4



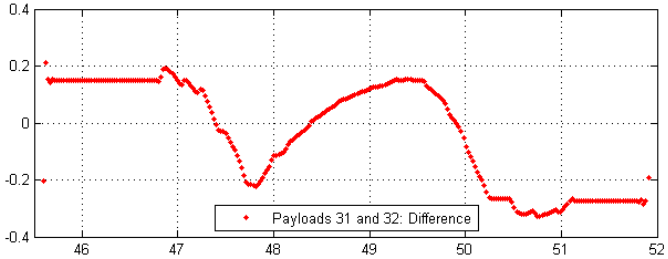
EL1



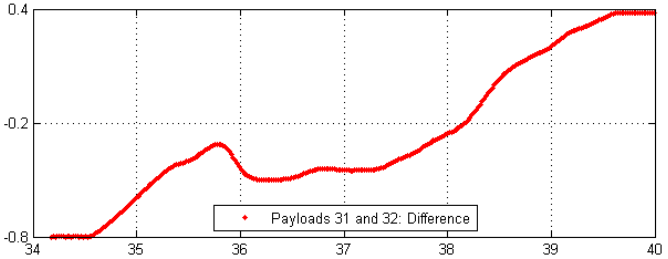
EH3



EH6



F3



Range shift of imaging section of patterns

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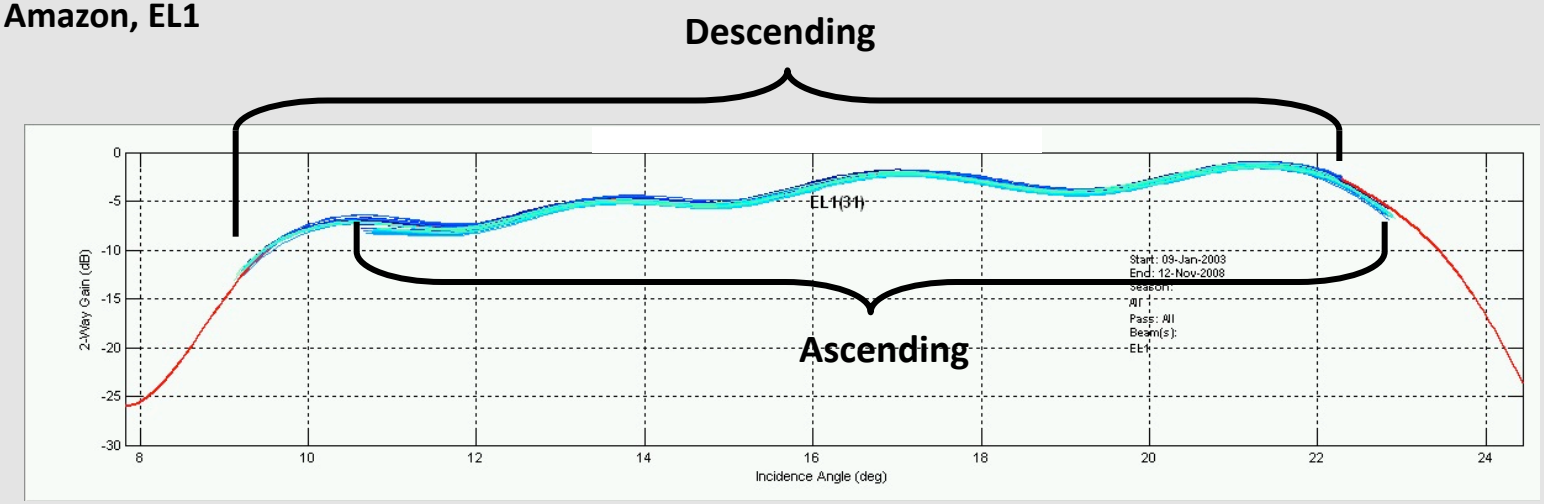
Amazon, EL1

2003-2004



2007-2008

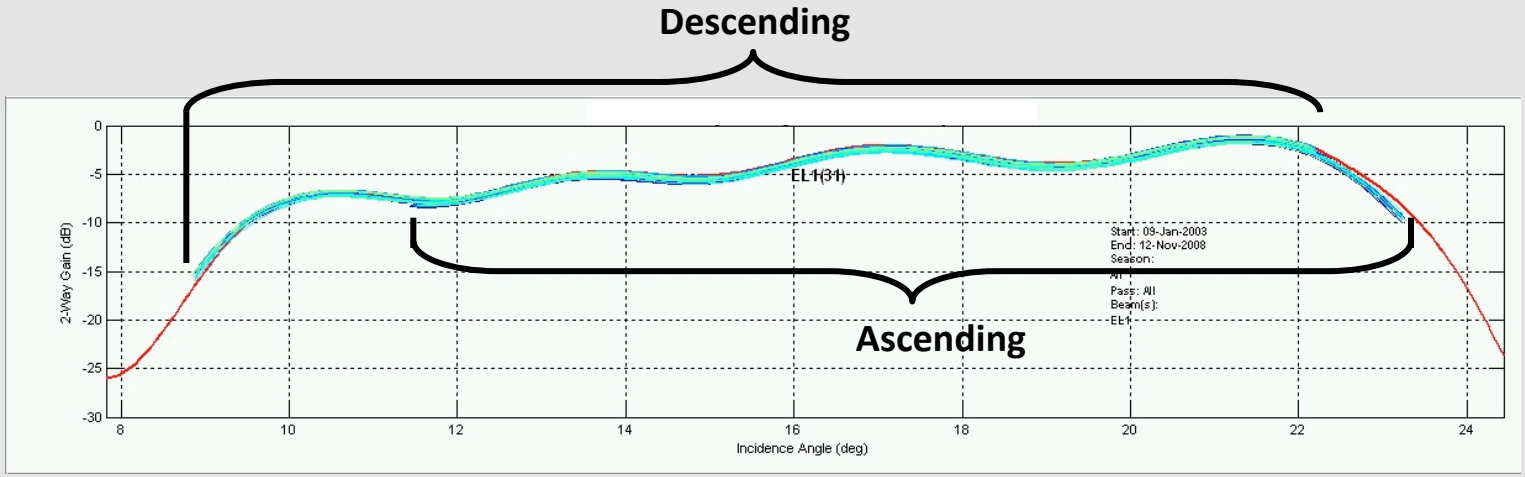


Image Quality after recalibration

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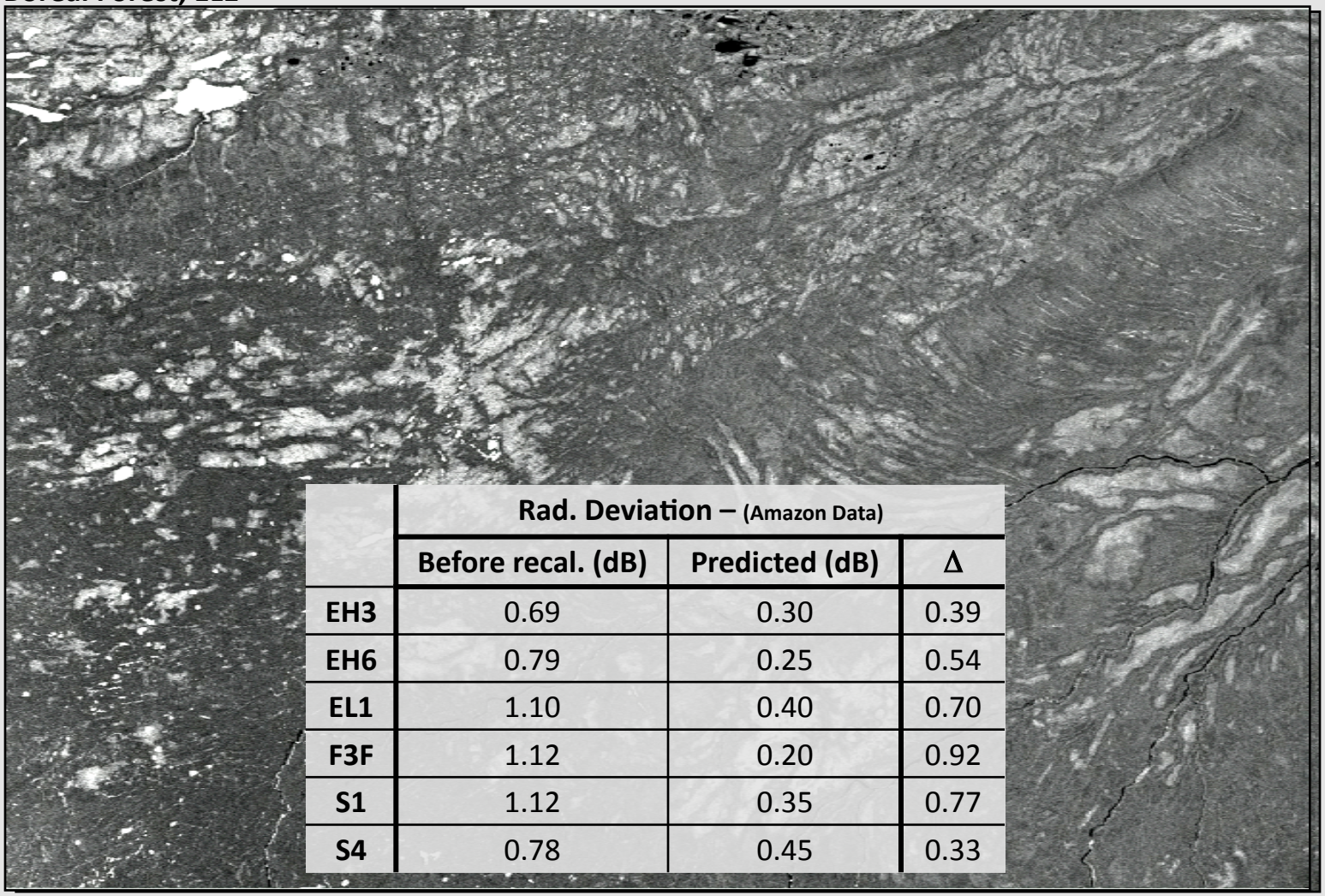
Boreal Forest, EL1



	Rad. Deviation – (Amazon Data)		
	Before recal. (dB)	Predicted (dB)	Δ
EH3	0.69	0.30	0.39
EH6	0.79	0.25	0.54
EL1	1.10	0.40	0.70
F3F	1.12	0.20	0.92
S1	1.12	0.35	0.77
S4	0.78	0.45	0.33

Canadian Boreal Forest Site

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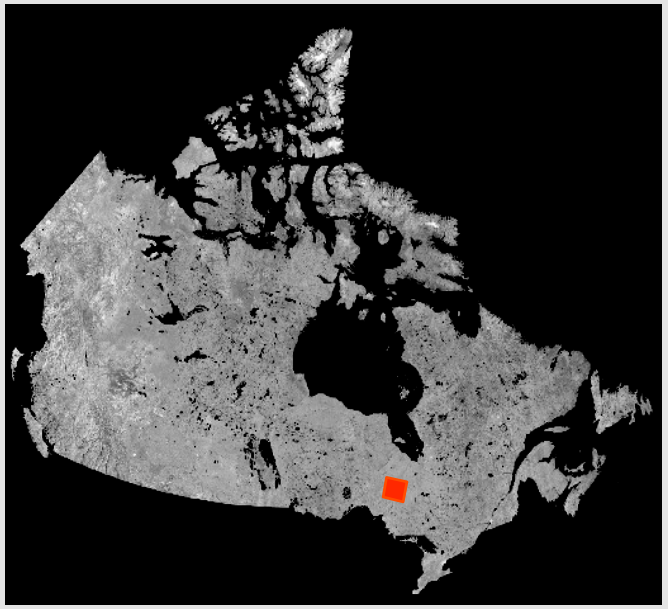
Since restriction (Oct 08) and termination (Feb 09) of On-Board Recorder (OBR) operations, utilization of boreal forest data for image monitoring has increased to compensate unavailability of Amazon data.

Elevation patterns routinely examined at the site for EL1, Standard beams and Wide beams.

To better mitigate temporal and seasonal variations, monthly-based backscatter models of the area now replace the previous seasonal profiles.

Twelve monthly gamma models were derived from the area, using R-1 data covering the last 5 years.



Achievable accuracy of relative radiometric measurements has remained basically the same:

1.2 dB (seasonal-based model)

1.1 dB (monthly-based model)

Measurement variability has decreased (σ):

0.8 dB (seasonal)

0.5 dB (monthly)

Cross-calibrating R-1 with R-2 at the boreal forest

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1. A pair of twin R1-R2 images is acquired, same beam and location, at around the same time period;
2. The R2 beam pattern is removed from the calibrated R2 image;
3. To cancel scene-specific constraints, the obtained scene backscatter is subtracted from the R1 image, processed with no antenna pattern correction:

   ⇨ R1 beam pattern.

The interval between the 2 acquisitions must be:

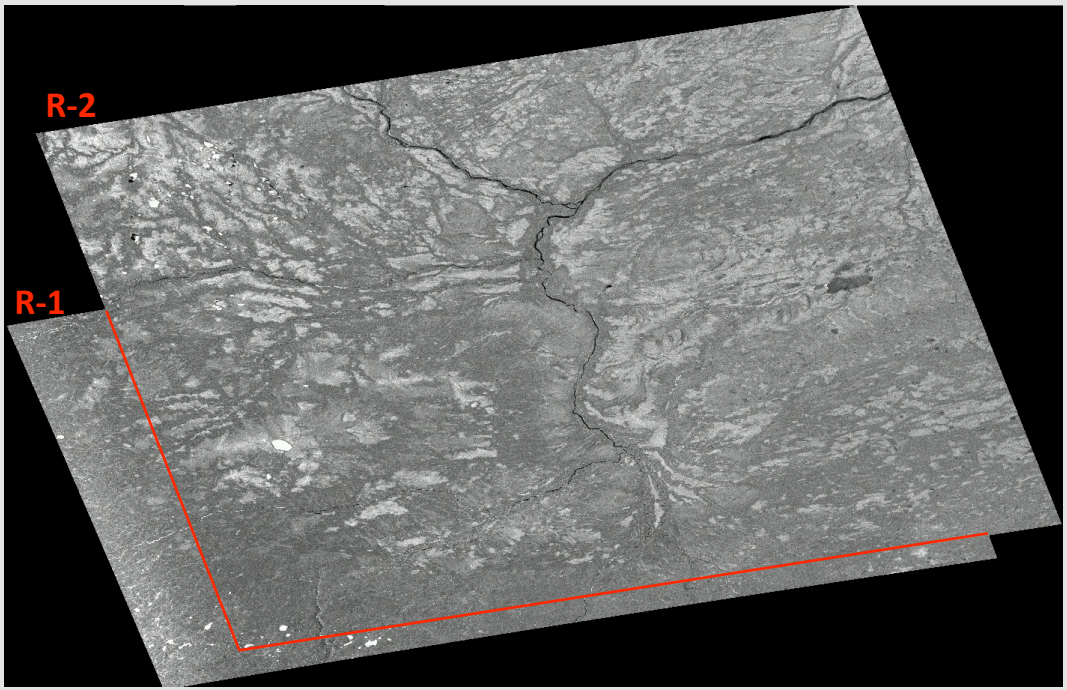
(2n+1) X 12 days

n={0,1,2,…}

A viable R1-R2 pair is difficult to obtain, due to changing conditions at the site.

The range offset between the datasets does not allow for a full range measurement.

Planning logistics also an issue.



Cross-calibrating R-1 with R-2 at the boreal forest

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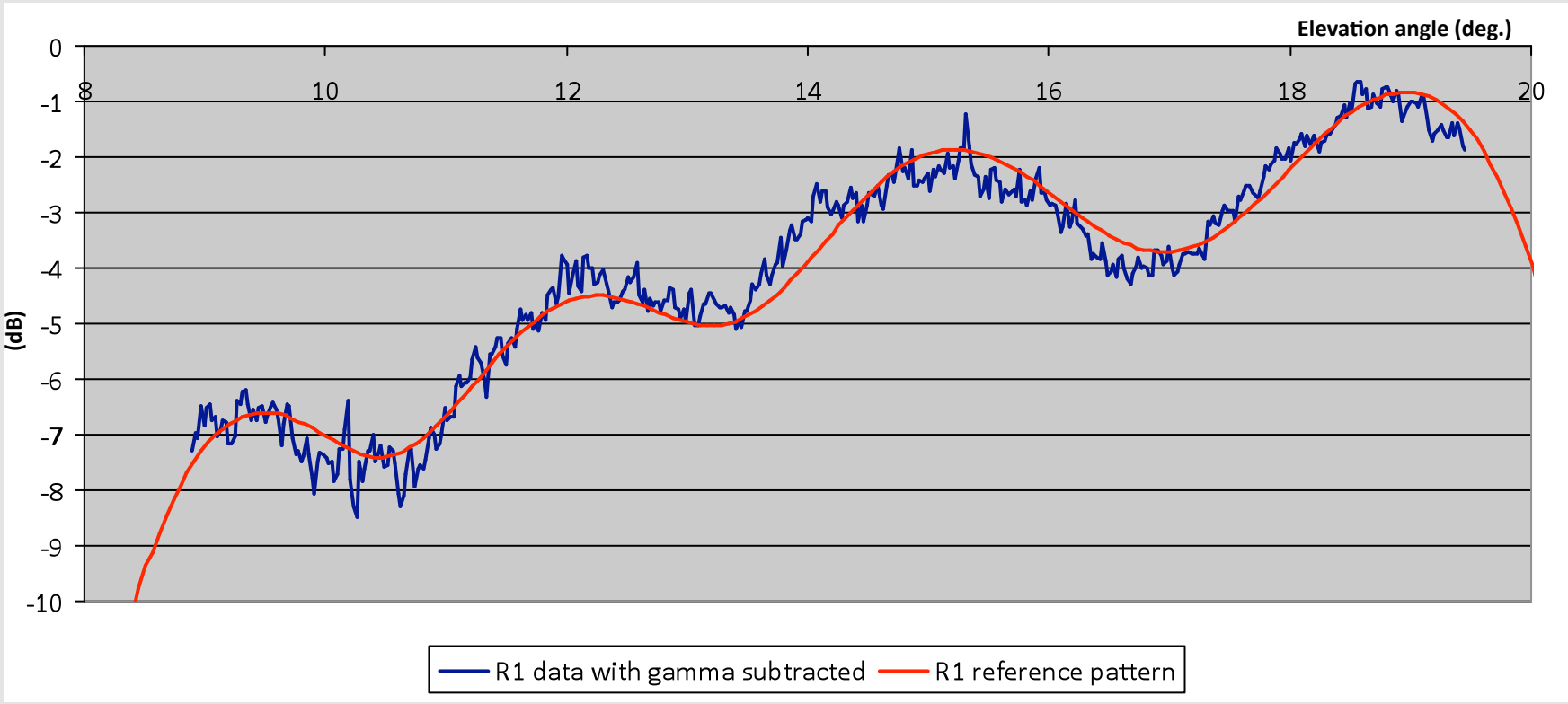
EL1 R-1/R-2 datasets, spring period



Radiometric deviations obtained from this approach are down 0.3 dB compared to using the boreal forest site with monthly-based backscatter models.

The results obtained depend on the R-2 relative calibration accuracy.

Practicality of this approach is under evaluation.

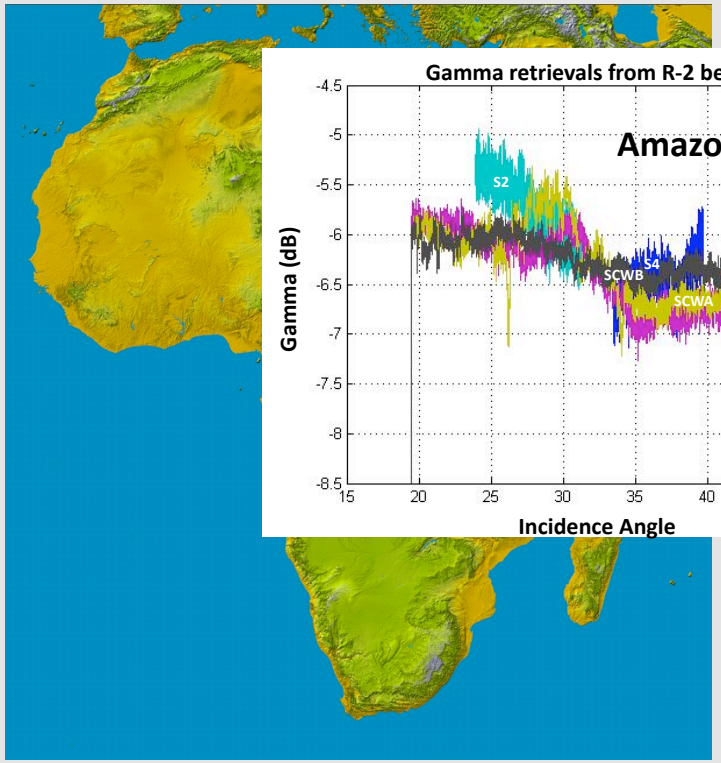
Congo

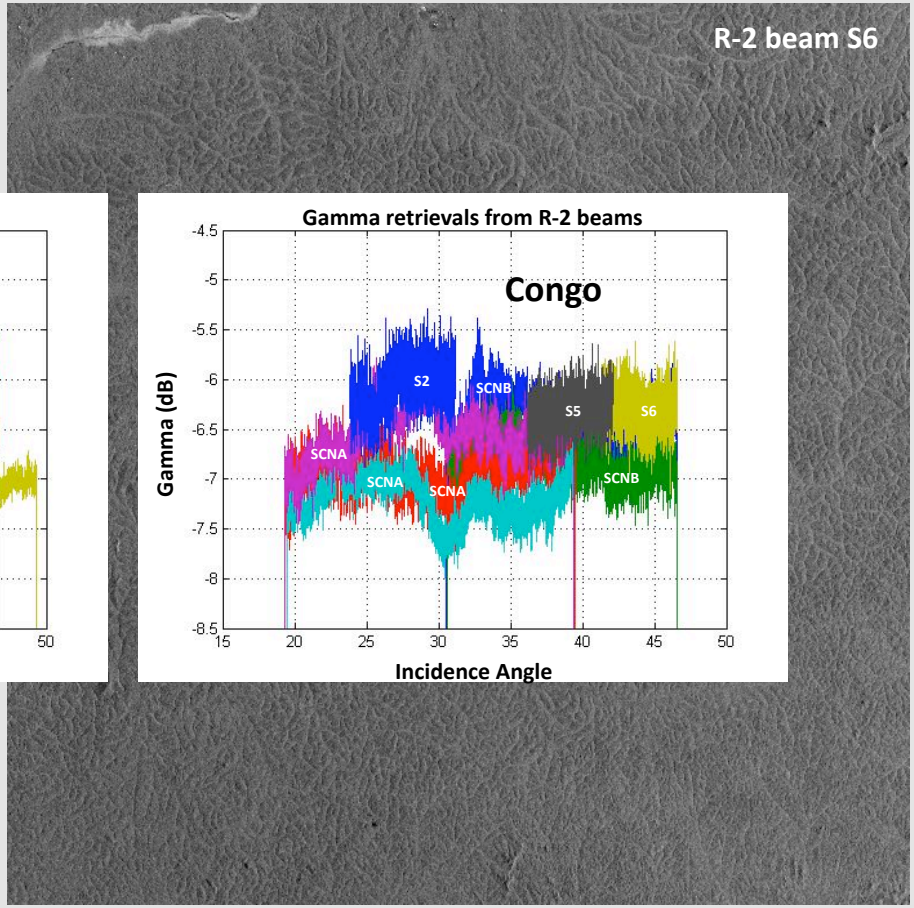
Potential sites were searched using optical satellite images and topographical data.

3 prospect areas were identified, two of which were national parks.

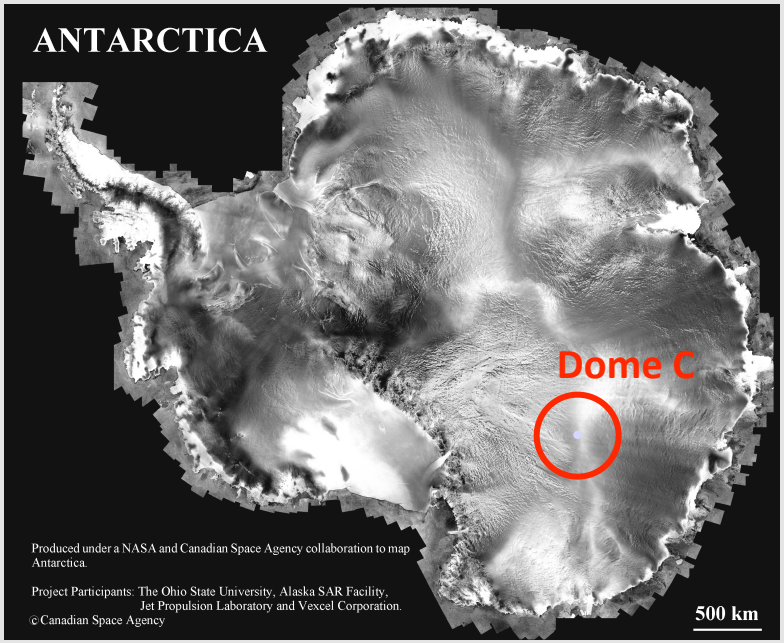
R-2 campaign:

- Characterization of the areas;
- Beam pattern measurement trials.





Antarctica – Dome-C area



Dome-C as a candidate external calibration site for microwave sensors was presented at the CEOS WGCV Plenary in early 2008.

- **High-latitude offers frequent overpasses of crossing orbits;**
- **Light wind and uniform direction: minimal variability in surface roughness effects;**
- **An acquisition campaign was undertaken at the CSA to study the site at C-band and report to the CEOS.**

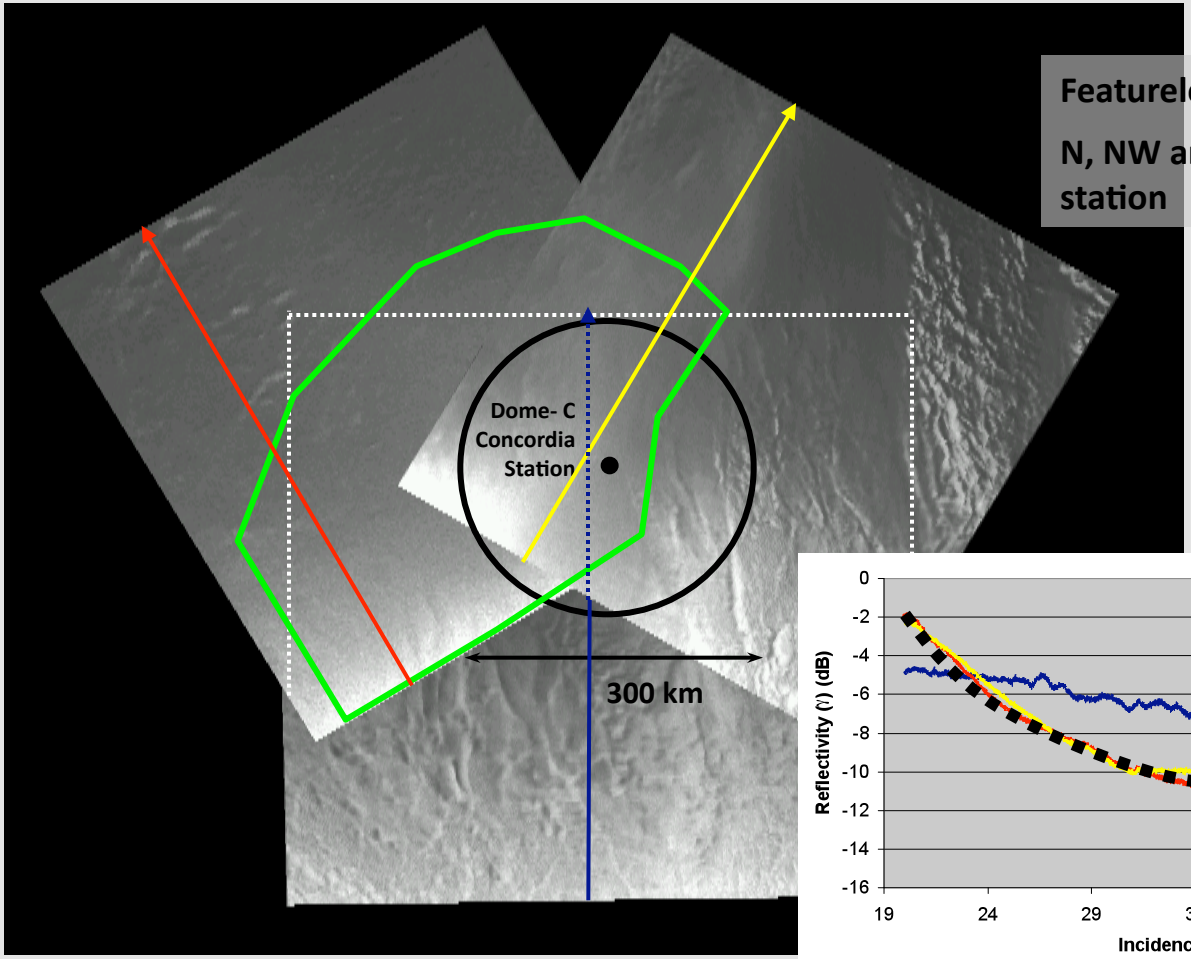
R-1 data were first acquired in 2008 to examine the site at various spatial resolutions.

R-2 acquisitions commenced later in 2008 with the following objectives:

1. Locate the delimitations of a suitable area for long-term data collection;
2. Characterize, in HH, VV and HV, the backscatter profile (gamma) and anisotropy in elevation;
3. Perform elevation beam pattern measurements.

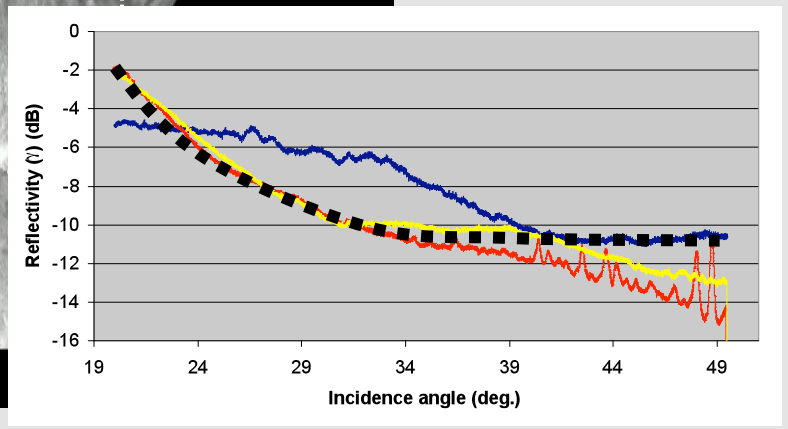
Antarctica – Dome-C area

R-2 SCWA HH data - Backscatter profiles



Featureless terrain:

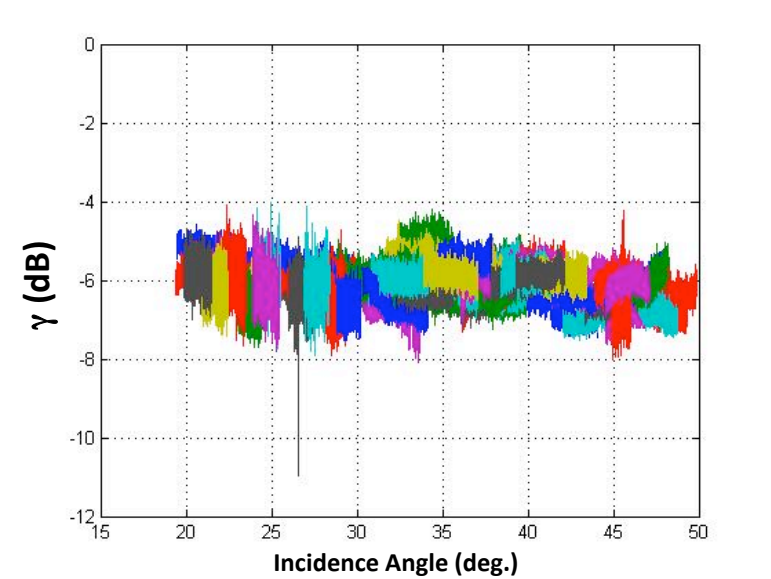
N, NW and SW of Concordia station



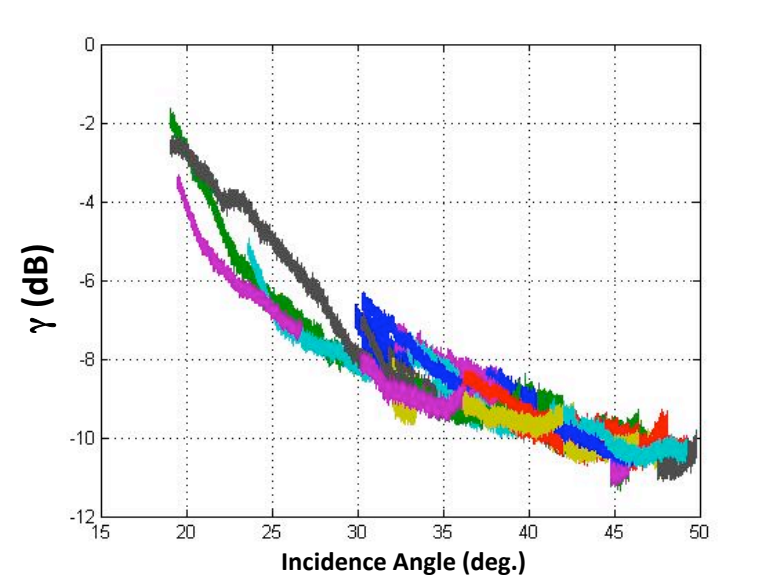
Antarctica – Dome-C area

Backscatter profiles, R-2 HH data

Amazon



Dome-C



Antarctica – Dome-C area

Fine data acquisitions around Concordia Station (50 x 50 km)

HH Red

HV Green

Ascending

Various incidence angles

Descending

Various incidence angles

Antarctica – Dome-C area

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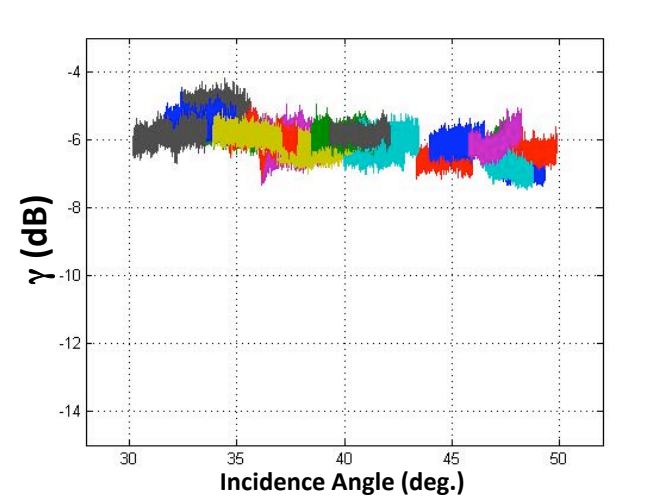
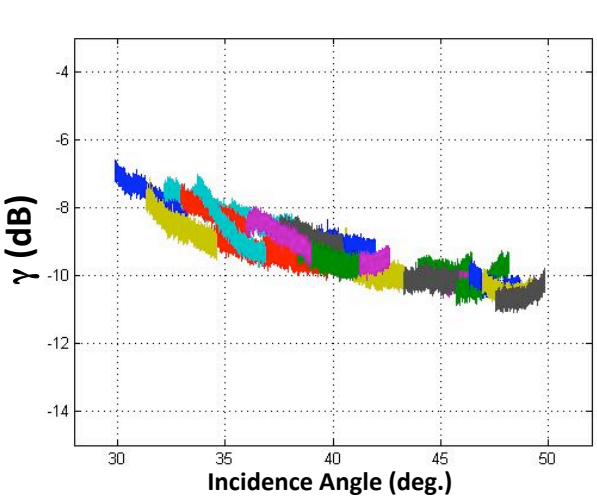
Backscatter profiles from R-2 Fine beams, HH

Amazon



Dome-C



A backscatter model was derived for Fine beam pattern measurement tests

Fine datasets were acquired over a period of one year, in vicinity of the Concordia station:

- **Measurements give an average radiometric deviation of 0.41 dB, Amazon measurements on similar beams give 0.39 dB**
- **Standard deviation at both areas is around 0.25 dB**

Summary

Amazon and R-1 calibration: has allowed to show the progressive slowing down of beam pattern changes for R-1. The latest beam recalibrations extended the range of the calibrated portion.

Amazon combines many factors contributing to making it an area of choice for elevation beam pattern measurements: vast uncut areas, large-scale flatness, etc.

Canadian boreal forest: using the selected area for beam pattern measurements presents challenges that require adaptive approaches. Monthly reflectivity models of the site were derived to partly overcome seasonal variations.

Monitoring R-1 beams using R-2 as a means to cancel out site constraints appears feasible. The accuracy of the measurements is complex to evaluate, depends on the uncompensated site artifacts and R-2's relative calibration accuracy.

Congo: while the biomass shares similarities with the Amazon rain forest, terrain height variations as well as deforested areas are limiting factors for achievable accuracy and swath sizes. More data will be acquired at the areas identified.

Dome-C: the area's stability and smoothness suggest a good potential for high accuracy measurements, however the elevation anisotropy requires more characterization. The useable area needs also to be better defined. Cross-pol. levels at C-band are down -18 dB at 35° inci. and higher, which is a limitation.

Image Footprint Offset vs Time