

# **‘Landsat – like’ image sensors programs**

- 1. SPOT – France 1986**
- 2. IRS – India 1995**
- 3. CBERS – China/Brazil 1999**
- 4. ASTER – USA/Japan 1999**
- 5. Sentinel 2 – Europe 2015**

***Next week: lectures in 5-154 ?***

# SPOT Program (Satellite Pour l'Observation de la Terre) France > 1986

**satellites :** SPOT 1 (21/02/1986 - 1/11/2003)  
SPOT 2 (21/01/1990 - 30/06/2009)  
SPOT 3 (25/09/1993 - 14/11/1996)

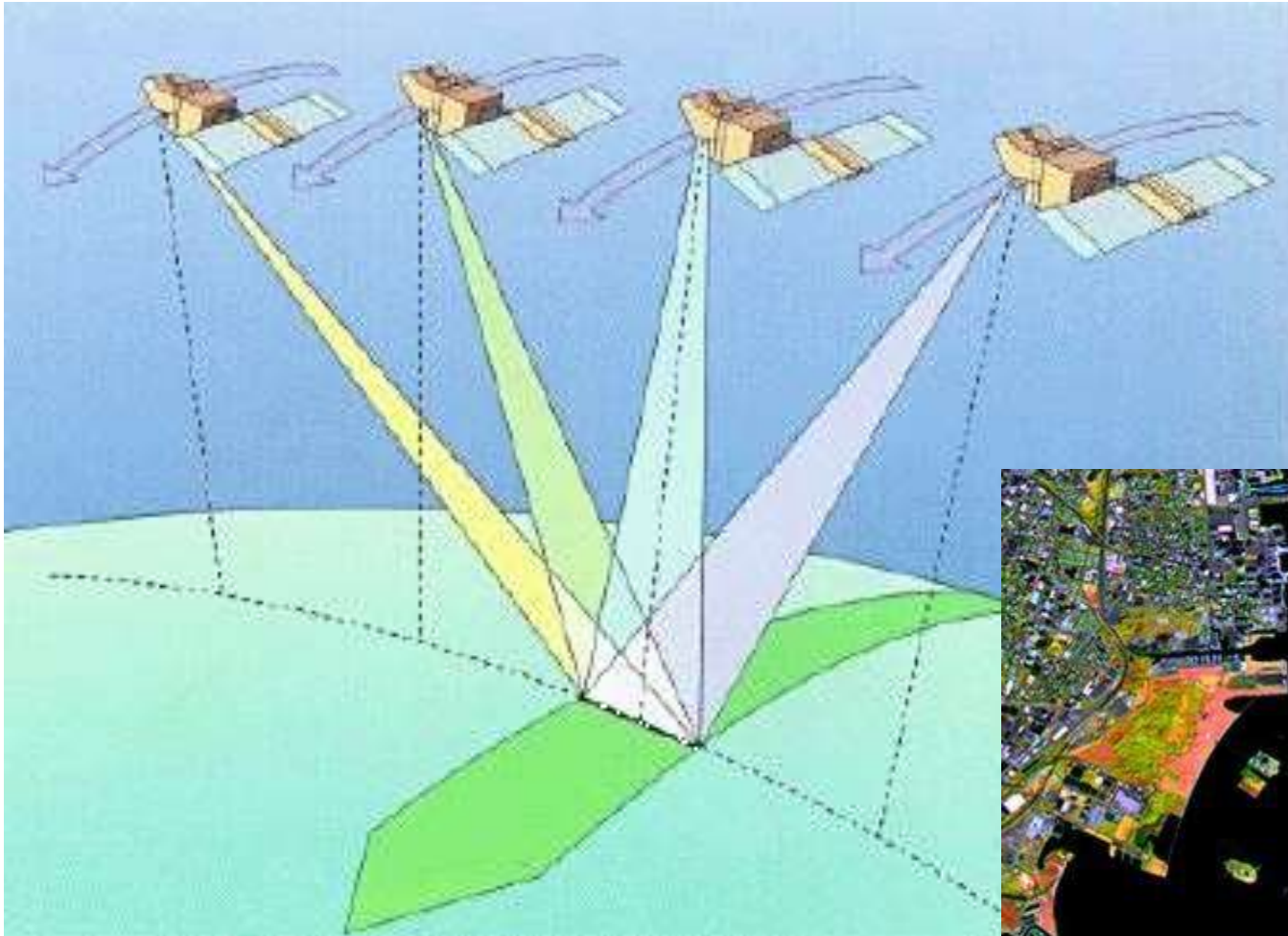
## HRV sensors

Mode	Band	Spectral band	Resolution
XS-multispectral	XS1	0,50 - 0,59 $\mu\text{m}$ (green)	20m x 20m
	XS2	0,61 - 0,68 $\mu\text{m}$ (red)	20m x 20m
	XS3	0,78 - 0,89 $\mu\text{m}$ (near IR)	20m x 20m
P-panchromatique	PAN	0,50 - 0,73 $\mu\text{m}$	10m x 10m



- Higher spatial resolution v Landsat TM
- .....but no mid-IR band
- Smaller 'footprint':  
60km swath versus 185km

**Off-nadir (+27 to -27 degrees) viewing capability of SPOT HRV enables a short revisit interval of 1 to 3 days (whiskbroom v pushbroom sensor)**



New York Sept 11, 2001



# High resolution SPOT (France)

High Resolution Visible (HRV) bands 1986 - >

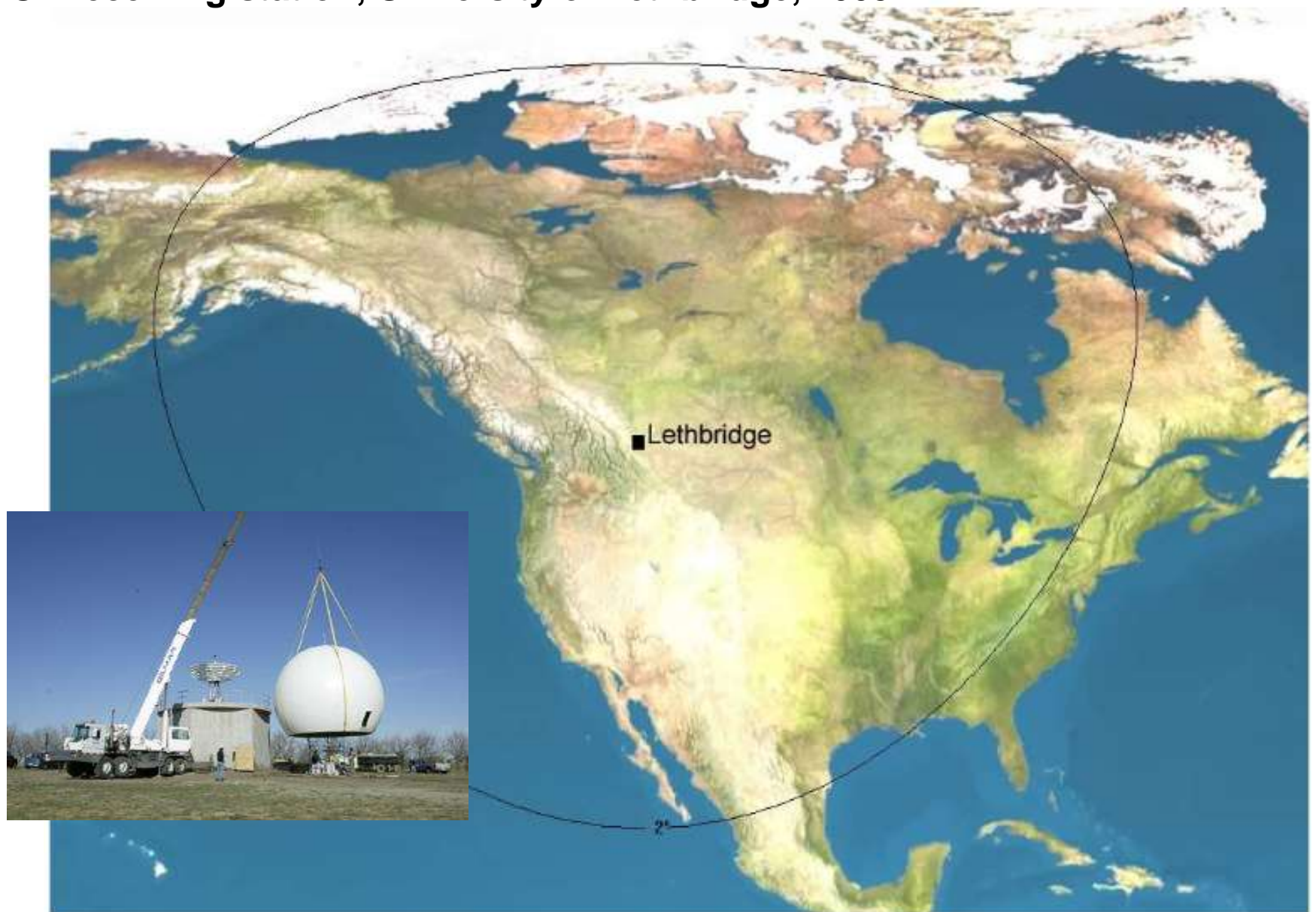
SPOT 1-3: 1986, 1990, 1993

Mode	Band	Spectral band	Resolution
XS-multispectral	XS1	0,50 - 0,59 $\mu\text{m}$	20m x 20m
	XS2	0,61 - 0,68 $\mu\text{m}$	20m x 20m
	XS3	0,79 - 0,89 $\mu\text{m}$	20m x 20m
P-panchromatique	PAN	0,51 - 0,73 $\mu\text{m}$	10m x 10m

SPOT 4- 5: 1998-> 2013, 2002 - 2015

Mode	Band	Spectral band	Resolution
Multispectral	B1	0,50 - 0,59 $\mu\text{m}$	20m x 20m
	B2	0,61 - 0,68 $\mu\text{m}$	20m x 20m
	B3	0,79 - 0,89 $\mu\text{m}$	20m x 20m
	MIR	1,58 - 1,75 $\mu\text{m}$	20m x 20m
M - monospectral	PAN	0,61 - 0,68 $\mu\text{m}$	10m x 10m

## SPOT receiving station, University of Lethbridge, 2005



Iunctus Geomatics Corp. Ground Station Circle of Visibility: Up to 2°

# COST

Scene Type	Scene Size
Full Scene	60x60
1/2	40x40
1/4	30x30
1/8	20x20

Res.	Spectral Mode	Full Scene	1/2 Scene	1/4 Scene	1/8 Scene
2.5 m	False Color	10,125			
	Pan	6,750	5,050	3,375	2,550
5 m	False Color	6,750			
	Pan	3,375	2,525	1,165	1,275
10 m	MS	3,375	2,525	1,165	1,275

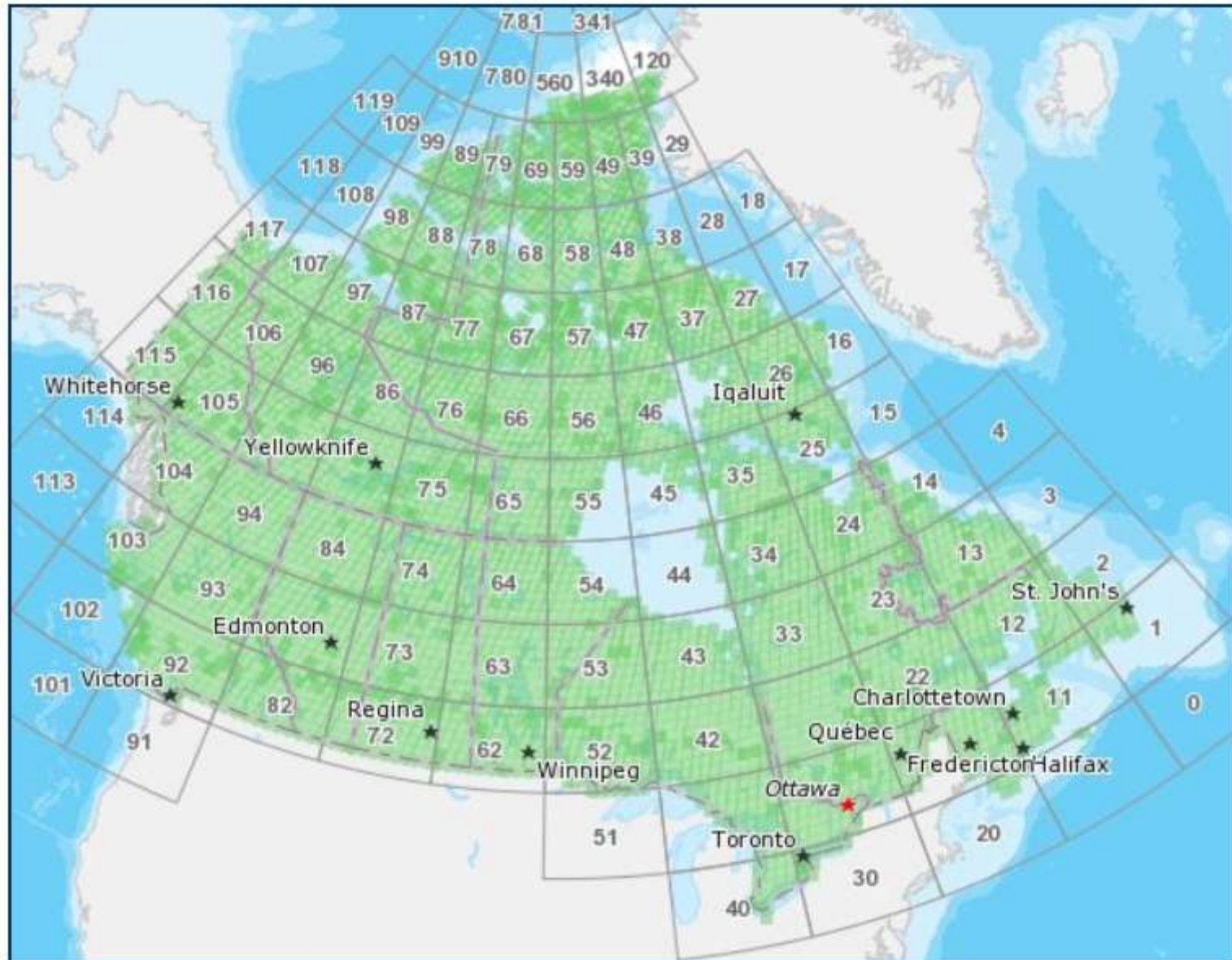
Canadian coverage from SPOT 4 and 5 data for years 2005-2010 are available free of charge from Geobase .....

# GeoBase Orthoimage 2005-2010 (geobase.ca)

- Agreement between SPOT (France) and NRCanada
- Provide SPOT 4 and 5 ortho satellite data.
- ~5,000 images were acquired between 2005 and 2010,
- complete coverage of Canada south of the 81<sup>st</sup> Parallel.
- Cost: \$5m
- update land cover mapping at higher than Landsat scale
- Available free for all Canada (to 81 north) - 'one time'

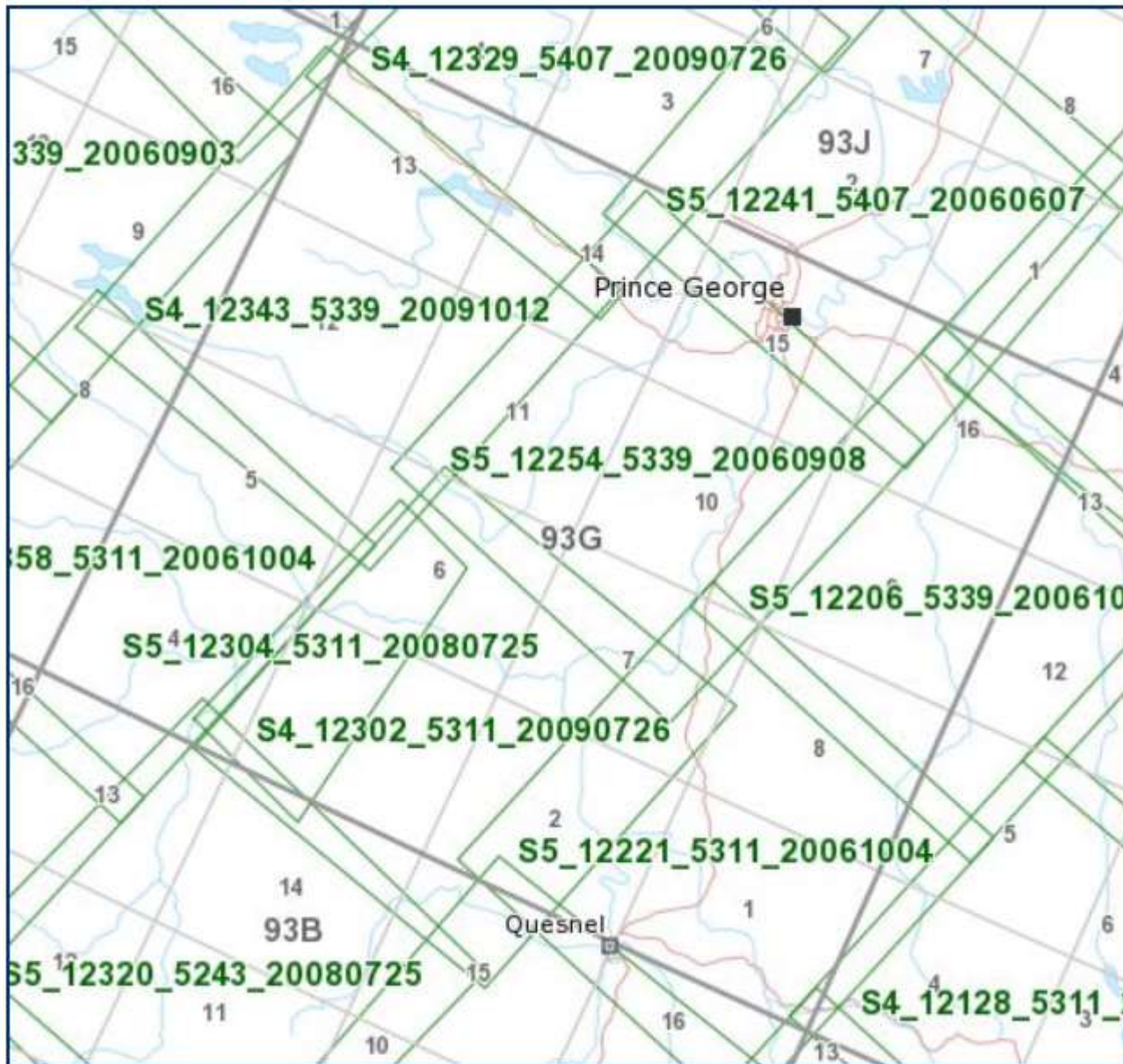


<http://geobase.ca> this site has been updated



Pre-sentinel 10m images





GeoBase SPOT 4  
/5 orthoimagery:

- a black and white (pan) band with 10 m resolution,
- three colour (multispectral) bands with 20 m resolution, and
- one short-wave infrared band with 20 m resolution.

GeoTIFF format

# VEGETATION Sensor (SPOT 4 and 5)

VEGETATION works independently from the HRVIRs. It includes a wide-angle radiometric 'camera' operating in four spectral bands (blue, red, near-infrared, and middle-infrared). Given its 2,250km swaths, this instrument is thus able to cover almost all of the Earth's dry land in just one day.

Archive data older than 3 months are available for free on the website <http://free.vgt.vito.be>

Band	Spectral band	Resolution	Applications
B0	0,43 - 0,47 $\mu$ m (blue)	1165m x 1165m	Oceanographic applications/ Atmospheric corrections
B2	0,61 - 0,68 $\mu$ m (red)	1165m x 1165m	Vegetation photosynthesis activity
B3	0,79 - 0,89 $\mu$ m (near IR)	1165m x 1165m	
MIR	1,58 - 1,75 $\mu$ m (middle IR)	1165m x 1165m	Ground and vegetation humidity

# SPOT 5: May 2002 - 15

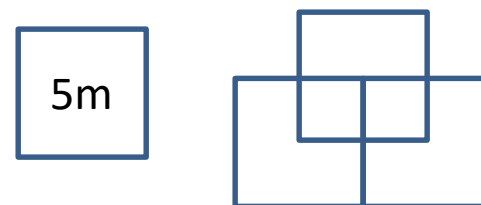
Same sensor wavelengths as SPOT 4 (ended Jan 2013):  
HRVIR + Vegetation plus ...

HRG sensors (High Resolution Geometric) sensors

Two HRG instruments are capable of generating data  
at 4 resolution levels with the same 60 km swath.

Mode	Band	Spectral band	Resolution
Multispectral	B1	0,50 - 0,59 $\mu\text{m}$	10m x 10m
	B2	0,61 - 0,68 $\mu\text{m}$	10m x 10m
	B3	0,79 - 0,89 $\mu\text{m}$	10m x 10m
	SWIR	1,58 - 1,75 $\mu\text{m}$	20m x 20m
M - monospectral	PAN	0,51 - 0,73 $\mu\text{m}$	5m x 5m (or 2.5m x 2.5m in supermode)

Supermode Graphic by Roger



We have Glacier and Mt. Revelstoke National Parks as 2.5m fused imagery



**SPOT 6: Sept 2012**

**SPOT 7: July 2014**

**New Astrosat Optical  
Modular Instrument  
(NAOMI)**

Resolution:  
1.5m PAN  
6m MS

Set up 180° apart

<http://www.satimagingcorp.com/gallery-spot-6.html>





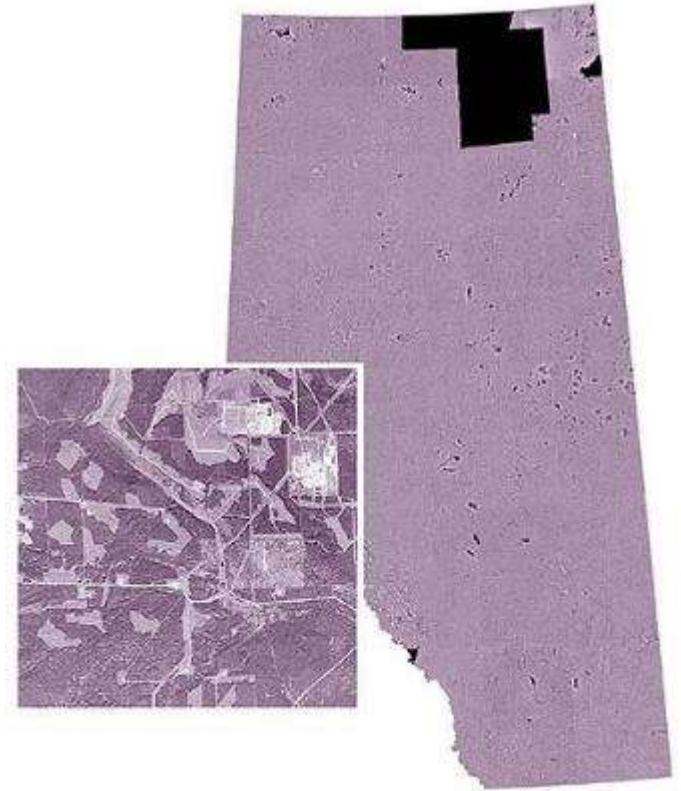
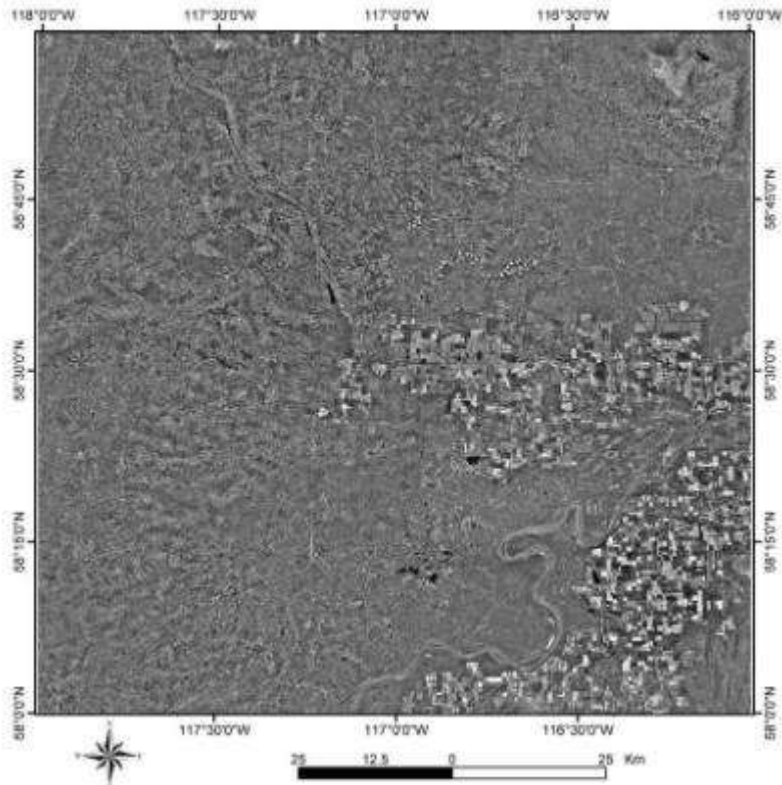
# Indian Remote Sensing

1988-1994 experimental 36m resolution

IRS-1C 1995 PAN + RGB + NIR

- PANchromatic camera of 6-meter resolution
- Linear Imaging Self Scanner (LISS)-III 24m

Complete coverage of Alberta  
6m -> 5m geocorrected



**ResourceSat-1 2003 (IRS-P6)**

**ResourceSat-2 2011**

**ResourceSat-3 2023**

LISS-4: 5.8 metre  
multispectral

LISS-3: 23.5 metre  
multispectral

Linear Imaging Self-  
Scanning Sensor-4

Linear Imaging Self-  
Scanning Sensor-3



# CBERS-1 (China-Brazil Earth Resources Satellite) 1999

Parameter	HRCC	IRMSS	WFI
Spectral bands ( $\mu\text{m}$ )	0.51 - 0.73 (PAN) 0.45 - 0.52 0.52 - 0.59 0.63 - 0.69 0.77 - 0.89	0.50 - 1.10 (PAN) 1.55 - 1.75 (SWIR) 2.08 - 2.35 (SWIR) 10.4 - 12.5 (TIR)	0.63 - 0.69 0.76 - 0.90
Spatial resolution	20 m	80 m (PAN & SWIR) 160 m (TIR)	260 m
Swath width (FOV)	113 km (8.32°)	120 km (8.78°)	890 km (60°)

With CBERS-2, Brazil adopted an open data distribution policy, ensuring free access through the internet to its catalogue and images.

- Online registration: any user can browse the catalogue, choose as many images as they want, and download for immediate use, with no cost or bureaucracy.

## CBERS 3 (failed in launch 2013)    CBERS 4 (2014)

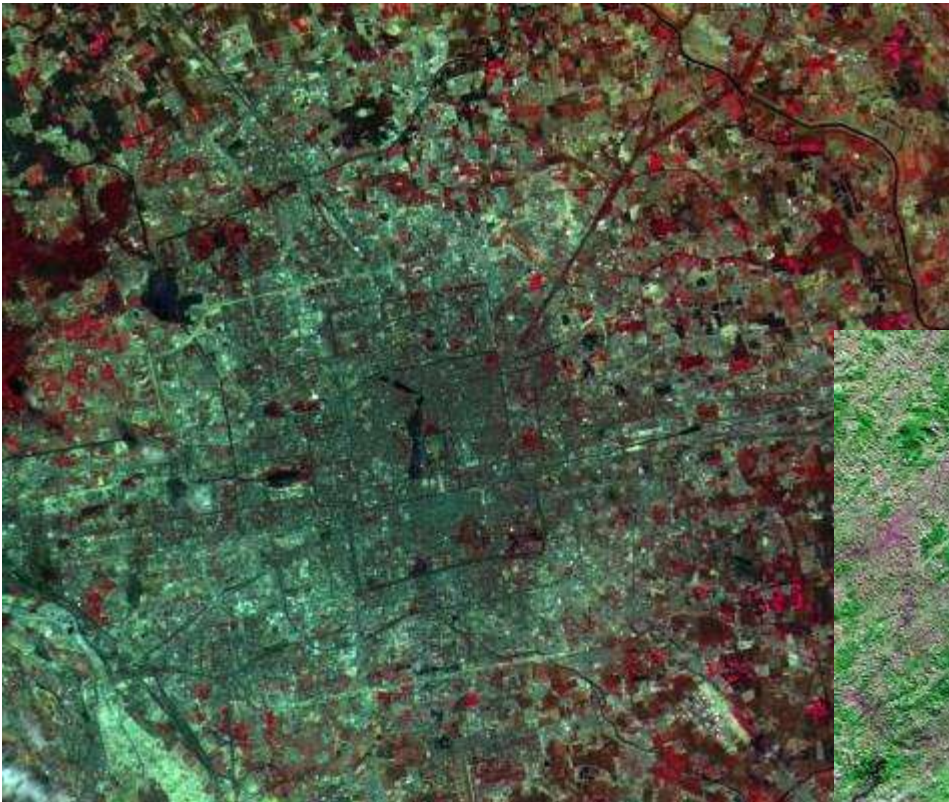
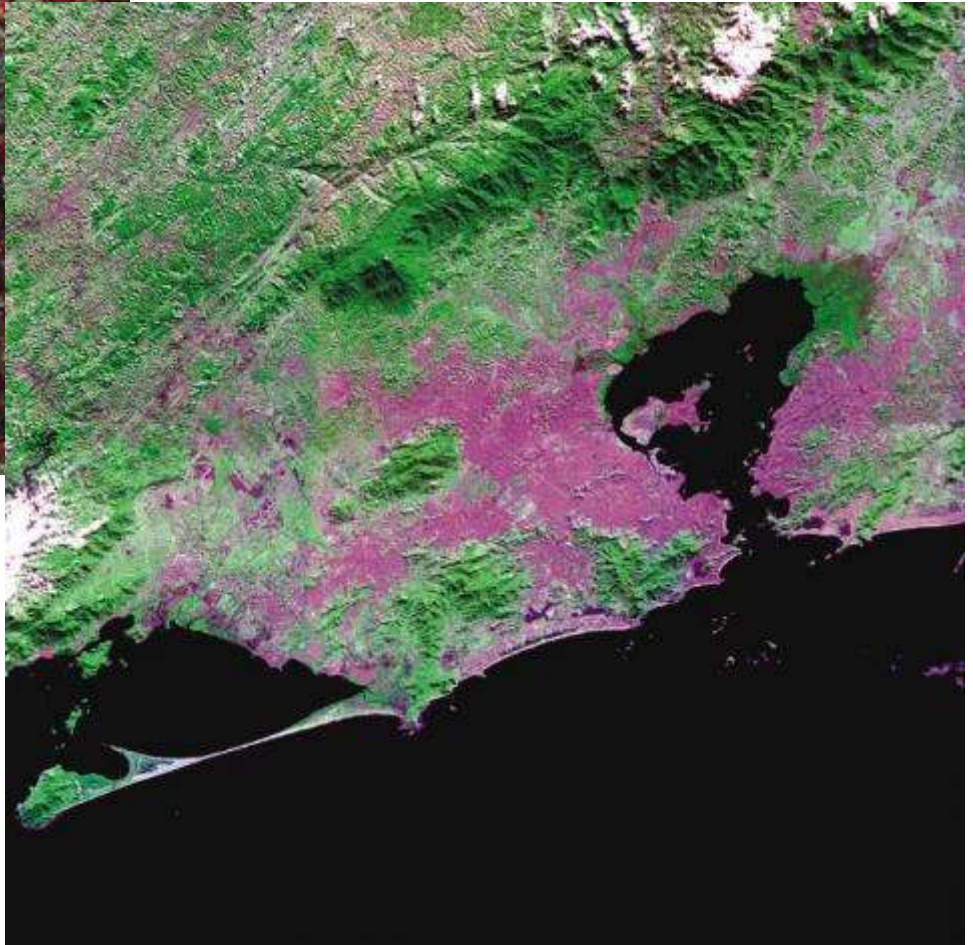
Parameter	<b>MUXCam</b>	<b>PanMUX</b>	<b>IRS</b>	<b>WFI</b>
Instrument provider	Brazil	China	China	Brazil
Observation technique	Pushbroom	Pushbroom	Scanner	Pushbroom
Spectral bands (µm)	0.45-0.52 (blue) 0.52-0.59 (green) 0.63-0.69 (red) 0.77-0.89 (NIR)	0.51-0.73 (Pan) 0.52-0.59 (green) 0.63-0.69 (red) 0.77-0.89 (NIR)	0.77-0.89 (NIR) 1.55-1.75 (SWIR) 2.08-2.35 (SWIR) 10.4-12.5 (TIR)	0.45-0.52 (blue) 0.52-0.59 (green) 0.63-0.69 (red) 0.77-0.89 (NIR)
Spatial resolution (m), GSD	20	5 (Pan), 10 m (MS)	40 / (80 m TIR)	64 (nadir)
Swath width (km)	120	60	120	866
Revisit capability (days)	No cross-track pointing	3 (cross-track pointing ±32°)		
Normal revisit time (days)	26	52 *	26	5
Data quantization (bit)	8	8	8	10
Data rate (Mbit/s)	68	68 (Pan), 100 (MS)	17	53
Data compression		2:1 in Pan		

<http://www.cbbers.inpe.br>



## CBERS images: the two capital cities

Rio de Janeiro



Beijing