

# CBERS-2B

## Radiometric and Geometric Quality Assessment



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# Launch

CBERS-2B was successfully launched on September 19, 2007

First images over Brazil were received on September 25, 2007



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# CBERS-2B Characteristics

Designed lifetime: 2 years

CBERS-3 launch is scheduled for 2010

Mass: 1,450Kg

Solar panel output power: 1,100W

Imaging duty cycle is 15 minutes (20 minutes max.)

Batteries: 2 x 30Ah NiCd

Orbit is 11 days behind CBERS-2

Three X-band downlink channels: two at 53Mbps and one at 60Mbps (all QPSK)

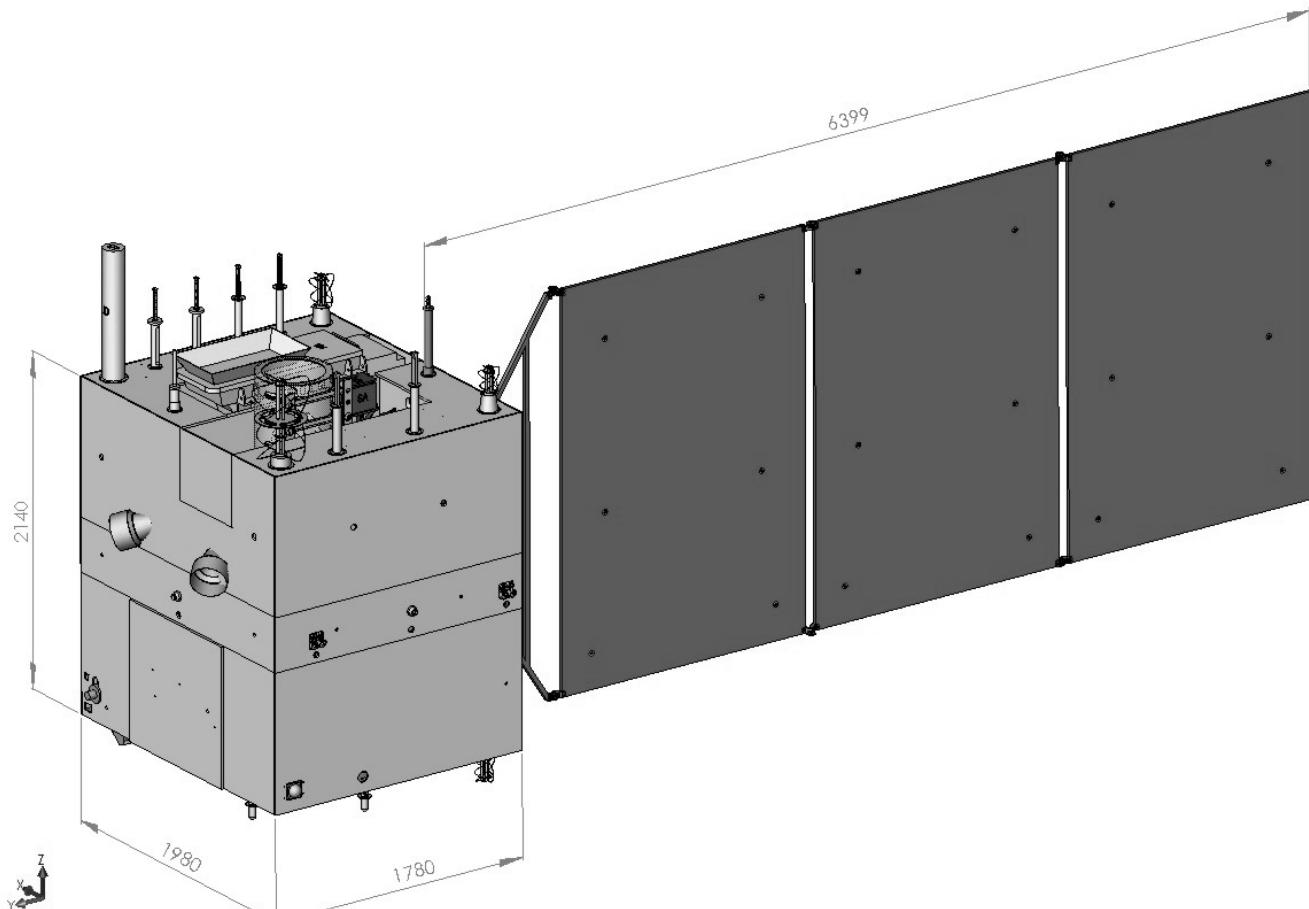


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# CBERS-2B



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# CBERS-2B Orbit

Height: 778Km

Inclination: 98.5°

Local time at descending node: 10:30AM

Orbital period: 100.26 minutes

Repeat cycle: 26 days

Inter-track distance: 107.4Km

Time between adjacent tracks: 3 days



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# CBERS-2B Cameras

Wide Field Imager Camera – WFI (Brazil)

CCD Camera (China)

High Resolution Camera – HRC (China)



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# WFI Camera

## Bands

B7: 0.63 – 0.69 μm  
B8: 0.77 – 0.89 μm

Swath: 890Km

Resolution: 258m

Sampling: 8 bits

Data rate: 1 Mbps

Image data transmitted together with HRC data



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# CCD Camera

## Bands

B1: 0.45 – 0.52 μm

B2: 0.52 – 0.59 μm

B3: 0.63 – 0.69 μm

B4: 0.77 – 0.89 μm

B5: 0.51 – 0.73 μm (panchromatic)

Swath: 113Km

Resolution: 20m

Side-looking capability:  $\pm 32^\circ$

Mirror pointing accuracy:  $0.07^\circ$



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# HR Camera

## Experimental payload

Not for distribution by international ground stations

### Band

B6: 0.45 - 0.85 μm

### TDI-CCD design

Swath: 27Km

Resolution: 2.36m

Data compression onboard, decompression  
by hardware at the ground station



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# Radiometric Evaluation

Signal to noise ratio

MTF performance – effective resolution

Effective spectral bands

Relative and absolute calibrations



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# CCD Signal to Noise Ratio

SNR (dB) Camera CCD CBERS-2B			
Band	Specification	Measured (lab)	Measured
	min	min	mean
B1	32	36.4	33.0
B2	31	40.1	34.0
B3	26	32.0	37.0
B4	29	29.3	31.0
B5	37	38.8	33.0



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# HRC Signal to Noise Ratio

SNR (dB) Camera HR CBERS-2B		
Band	Specification (min)	Measured (mean)
B6	26	31.6



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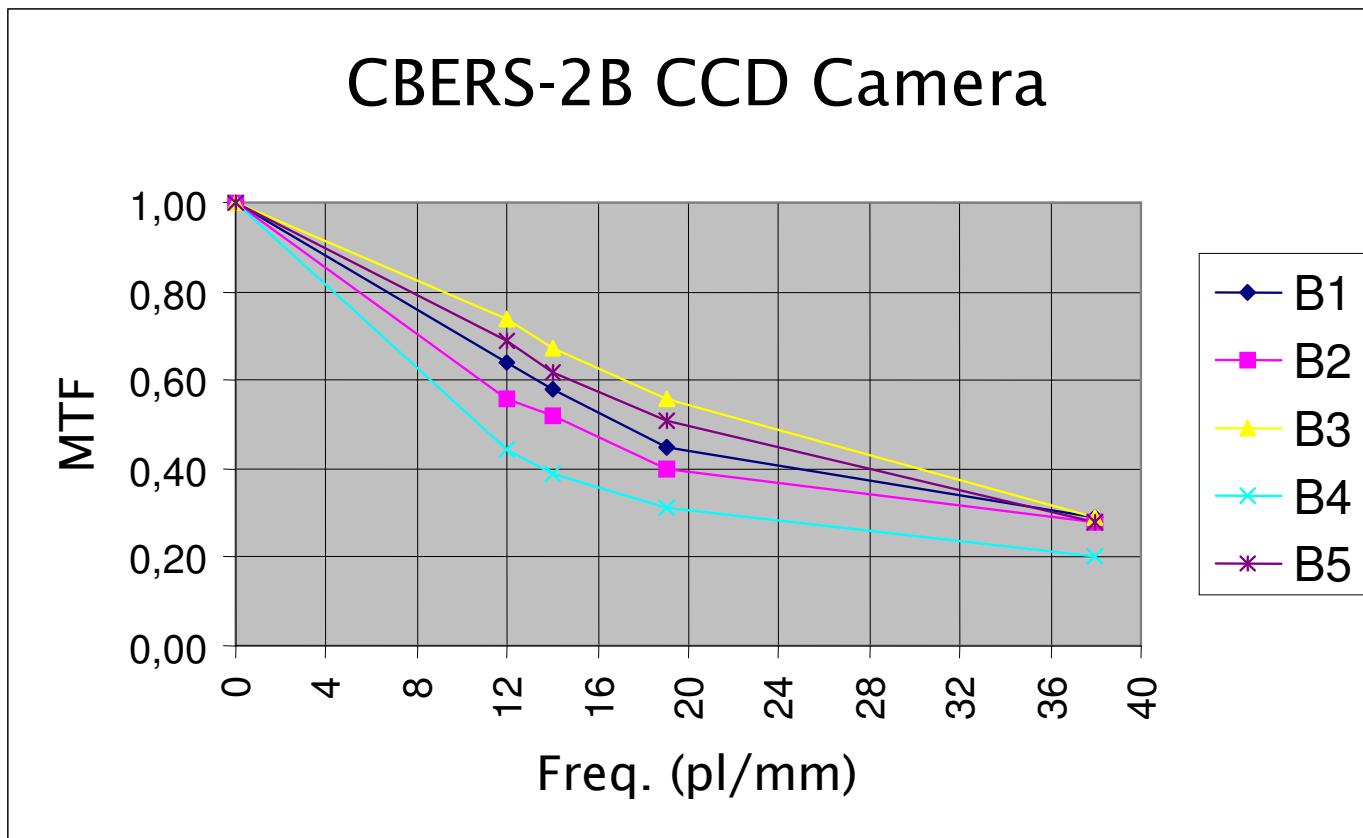
# WFI Signal to Noise Ratio

SNR (dB) CBERS-2B Camera WFI		
Band	Specification	Measured (mean)
	(min)	
B7	18	21
B8	24	24



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# MTF Performance



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# MTF Performance

Bands	Bands ( $\mu\text{m}$ )	CBERS2B CCD EIFOV (across-track during integration)	CBERS2 CCD EIFOV
B1	0.45 — 0.52	45	61 36
B2	0.52 — 0.59	51	59 35
B3	0.63 — 0.69	33	58 43
B4	0.77 — 0.89	70	63 37
B5	0.51 — 0.73	40	60 48



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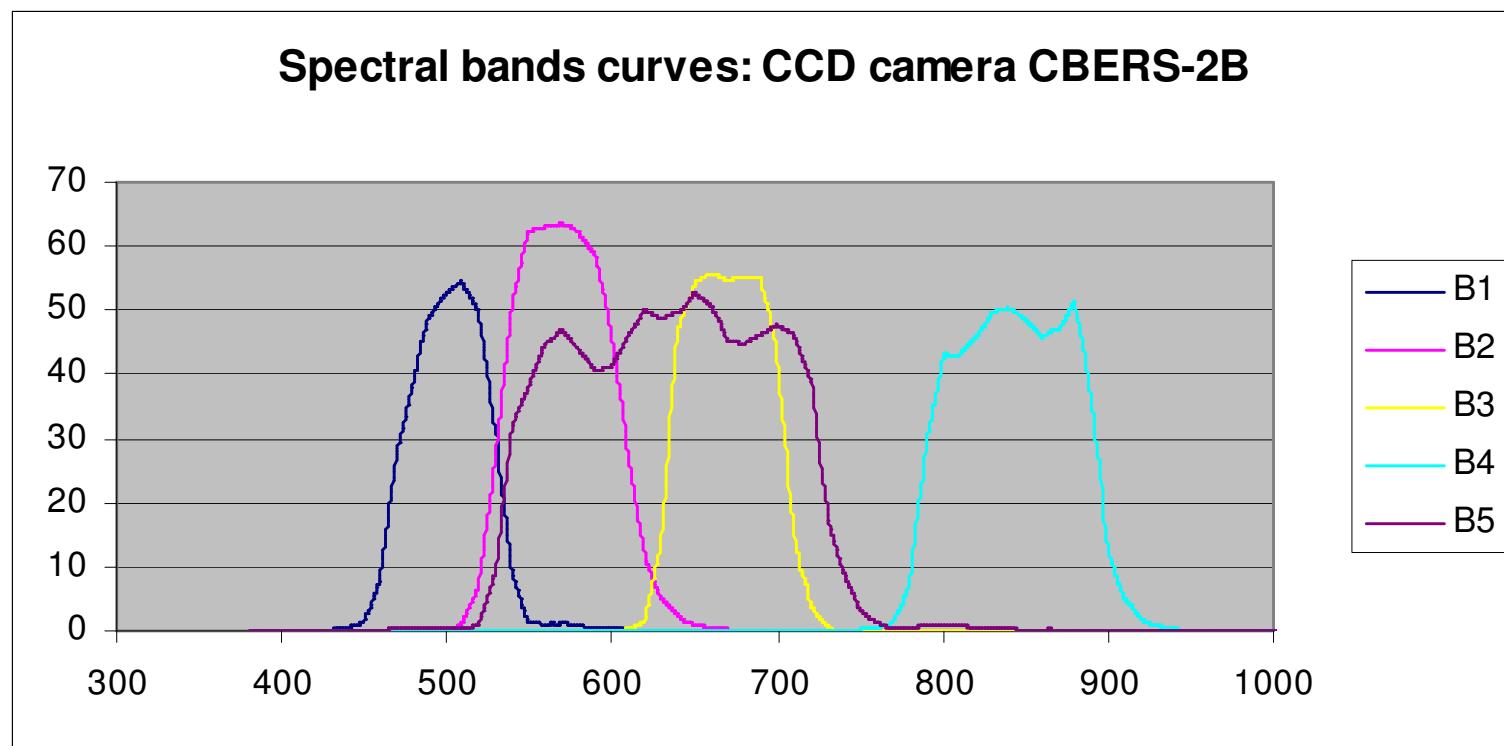
# MTF Performance

	Spectral Bands ( $\mu\text{m}$ )	MTF Across track, nadir (Nyquist frequency)
CCD	0.45 – 0.52	>0.28
	0.52 – 0.59	
	0.63 – 0.69	
	0.77 – 0.89	>0.20
	0.51 – 0.73	>0.28
HR	0.50 – 0.80	> 0.15
WFI	0.63 – 0.69	> 0.30
	0.77 – 0.89	



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# CCD Effective Spectral Bands



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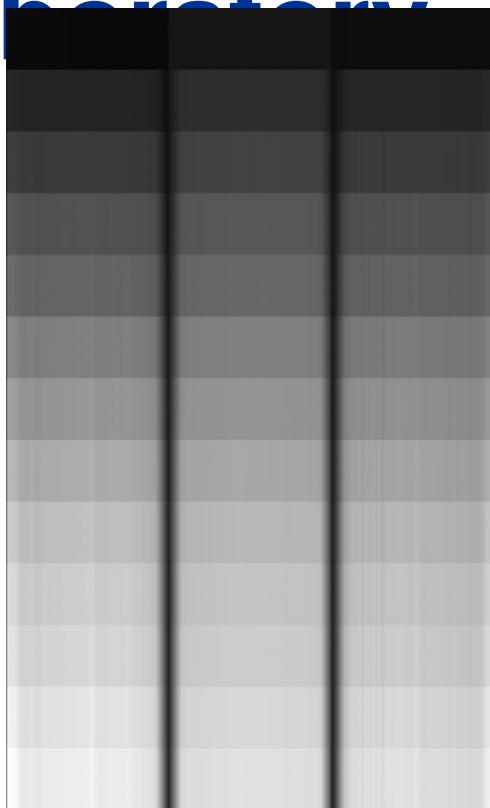
# CCD Effective Spectral Bands

Band	Specification ( $\mu\text{m}$ )	Measurement ( $\mu\text{m}$ )
B1	0.45 — 0.52	0.465 — 0.530
B2	0.52 — 0.59	0.530 — 0.605
B3	0.63 — 0.69	0.635 — 0.705
B4	0.77 — 0.89	0.785 — 0.895
B5	0.51 — 0.73	0.535 — 0.725

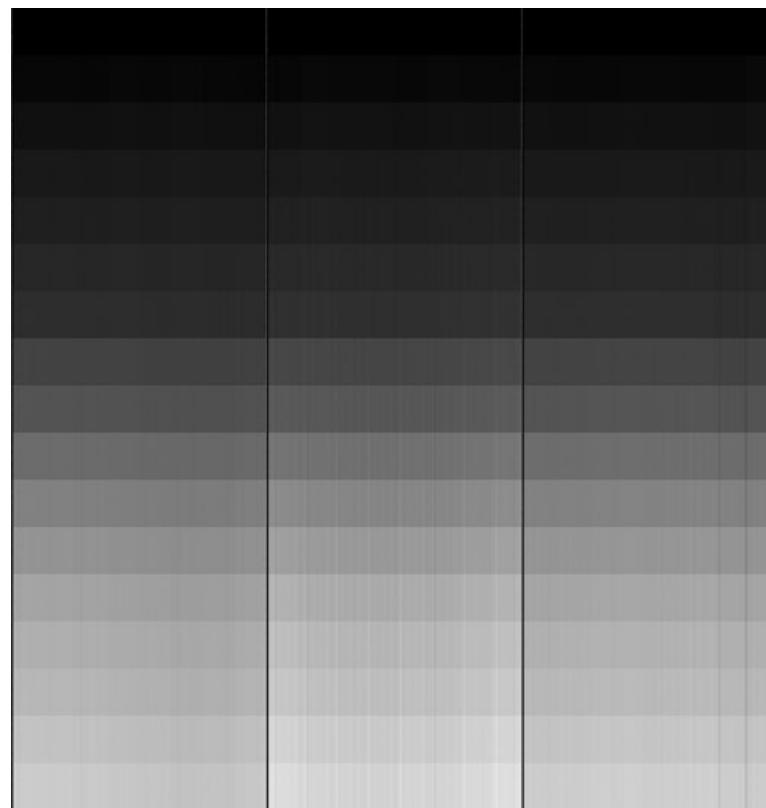


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# Relative Calibration in the Laboratory



CCD - 12 illumination levels

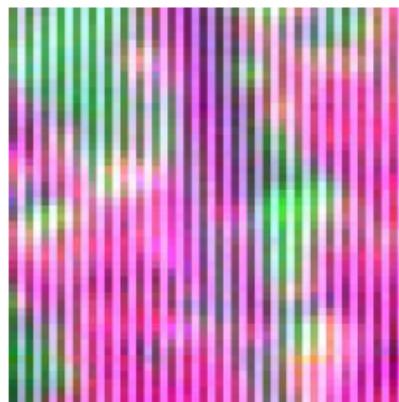


HRC - 16 illumination levels

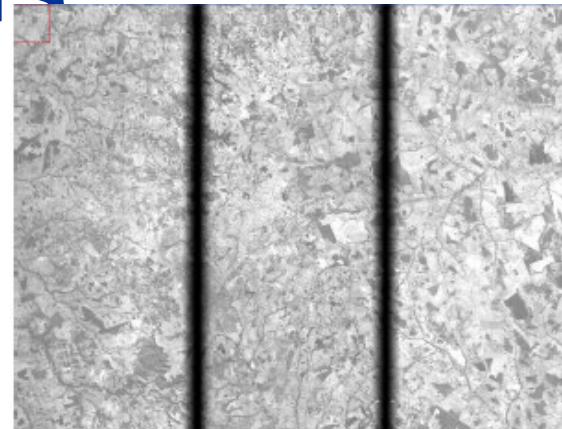


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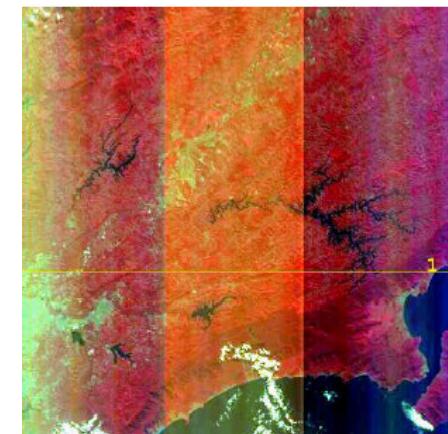
# CCD Relative Calibration Corrections



Even/odd detectors



Arrays overlap

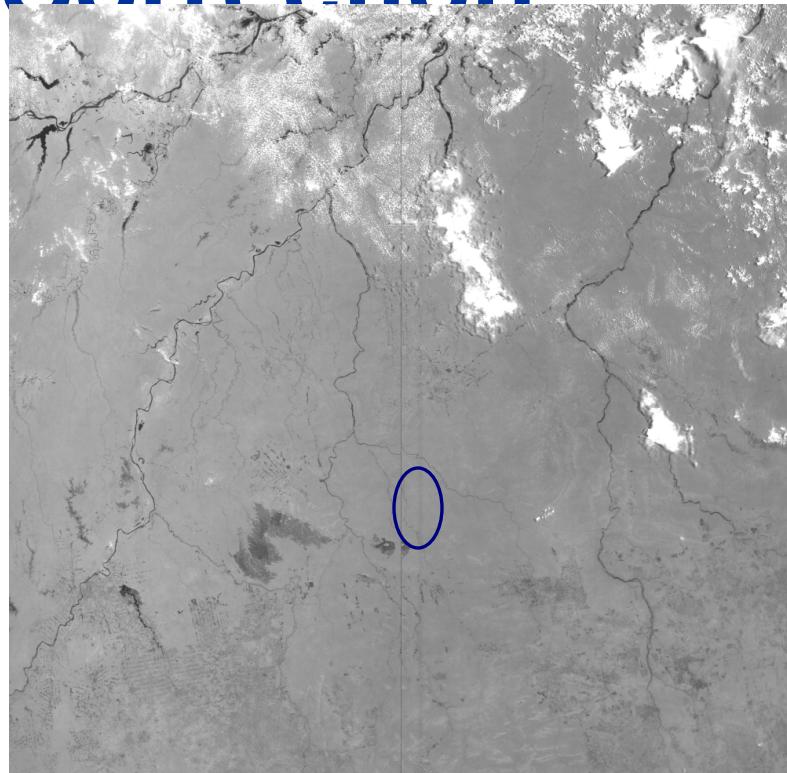


Arrays gain

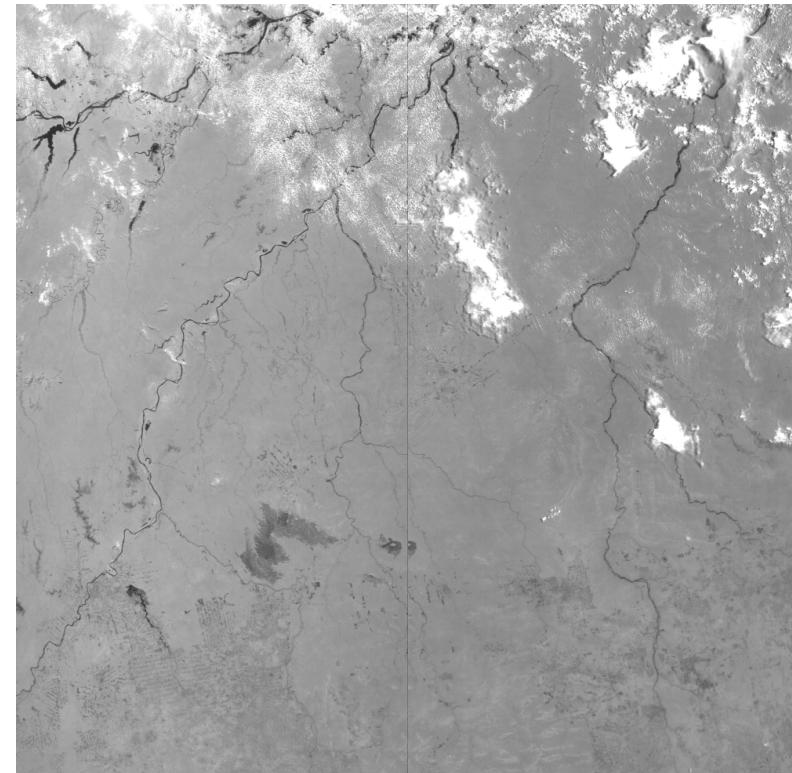


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# WFI Relative Calibration Correction



Band 2 – before



Band 2 – after



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# Estimation of CCD Absolute Calibration

Sphere level	Radiance B1	Radiance B2	Radiance B3	Radiance B4	Radiance B5
1	7,7897E-07	1,4029E-06	2,2186E-06	2,9146E-06	1,9229E-06
2	1,3629E-06	2,4664E-06	3,9203E-06	5,1818E-06	3,3931E-06
3	1,9398E-06	3,5430E-06	5,6900E-06	7,6108E-06	4,9122E-06
4	2,3821E-06	4,3867E-06	7,1053E-06	9,6096E-06	6,1222E-06
5	3,1503E-06	5,7458E-06	9,2153E-06	1,2319E-05	7,9586E-06
6	3,7621E-06	6,8594E-06	1,0997E-05	1,4674E-05	9,4978E-06
7	4,3125E-06	7,8791E-06	1,2646E-05	1,6905E-05	1,0919E-05
8	4,7997E-06	8,7877E-06	1,4148E-05	1,8983E-05	1,2207E-05
9	5,1212E-06	9,4001E-06	1,5176E-05	2,0449E-05	1,3086E-05
10	5,2863E-06	9,7445E-06	1,5821E-05	2,1488E-05	1,3624E-05
11	5,6124E-06	1,0368E-05	1,6861E-05	2,2968E-05	1,4514E-05
12	5,8266E-06	1,0793E-05	1,7621E-05	2,4108E-05	1,5153E-05



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# Estimation of CCD Absolute Calibration

DN B1	DN B2	DN B3 (channel 1)	DN B3 (channel 2)	DN B4	DN B5
7,2216	13,9768	22,5044	21,5410	36,5566	14,4474
12,9819	25,0359	40,9973	39,9283	66,0815	25,7021
18,6042	36,6945	60,0035	58,2990	97,6966	37,7373
23,1886	45,7590	75,3656	73,5063	122,9622	46,7995
30,5950	59,6615	97,7959	95,4196	157,1694	60,9508
36,8651	71,1365	117,0253	114,0012	186,5409	73,1810
42,6921	82,0510	134,7943	131,5717	213,7147	84,1012
47,7066	91,8982	150,6939	147,1328	219,2805	93,8939
51,2189	98,5908	162,1145	158,3522	218,7041	100,9613
53,2955	103,0795	169,3151	165,1416	217,7541	105,1296
56,8911	110,0054	180,0641	175,9726	216,2293	111,8926
59,4571	115,2994	188,3766	183,9564	215,5714	116,7368



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# Final Remarks on Radiometric Quality

CBERS-2B WFI has a better radiometric quality than CBERS-2 WFI

CBERS-2B CCD has the same radiometric quality than CBERS-2 CCD

CBERS-2B HRC effective resolution seems to be worse than the nominal resolution



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# Geometric Evaluation

System-corrected WFI, CCD, and HRC image data

Geographic position of scene center

Band to band registration accuracy

Internal accuracy

Positioning accuracy

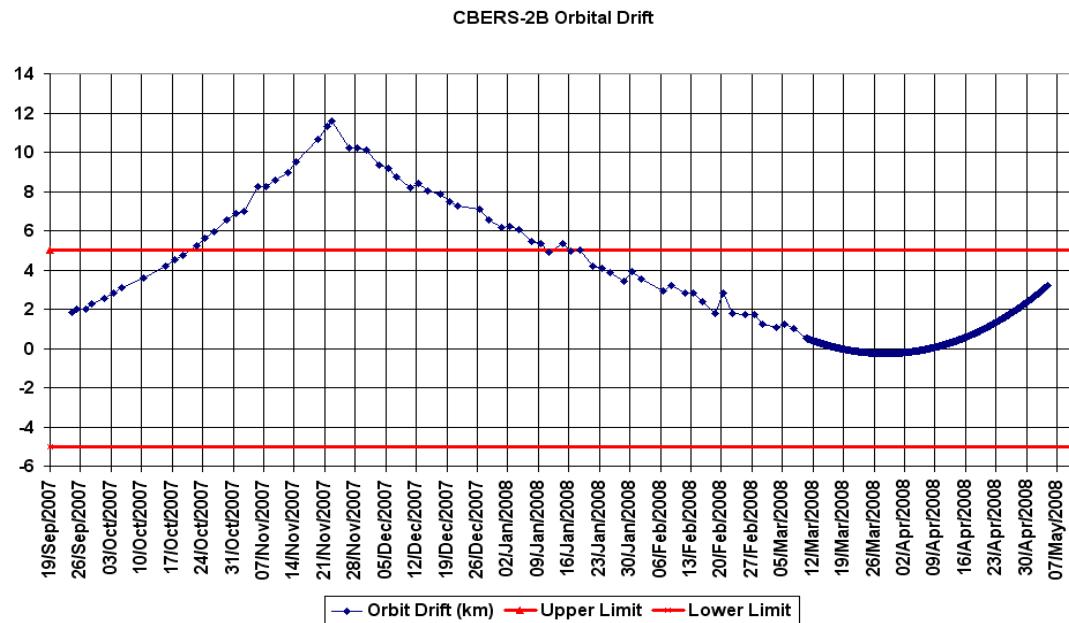


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# Geographic Position of Scene Center

Comparison between WRS nominal scene centers and actual scene centers



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# Band to Band Registration Accuracy

Reference and search windows are sub-images resampled to 1/11 of the original pixel size

Overlay all possible positions to determine similarity on selected control points

Matching position at each control point is determined by the maximum similarity value

Spatial distance between any reference window and the corresponding matching position defines the band-to-band mismatch

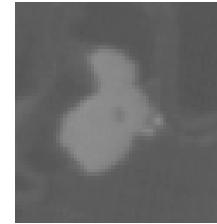
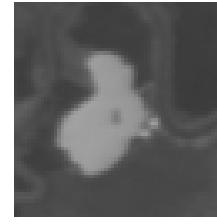
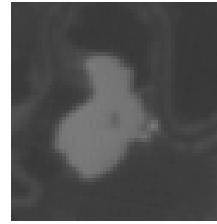
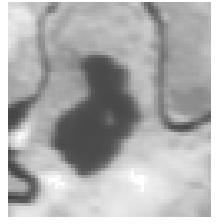
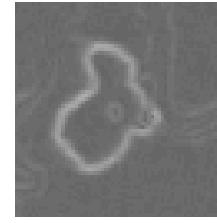
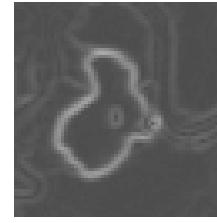
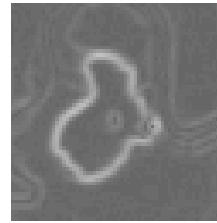
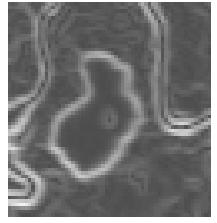


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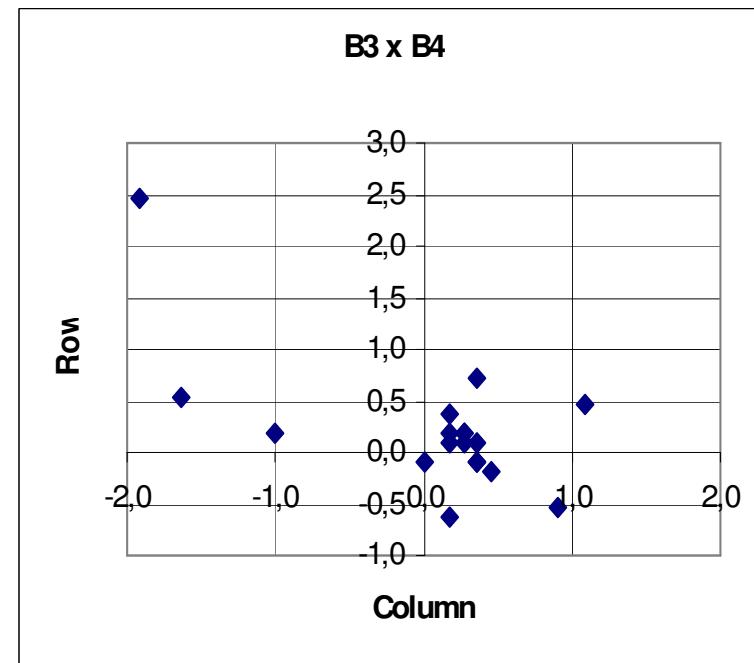
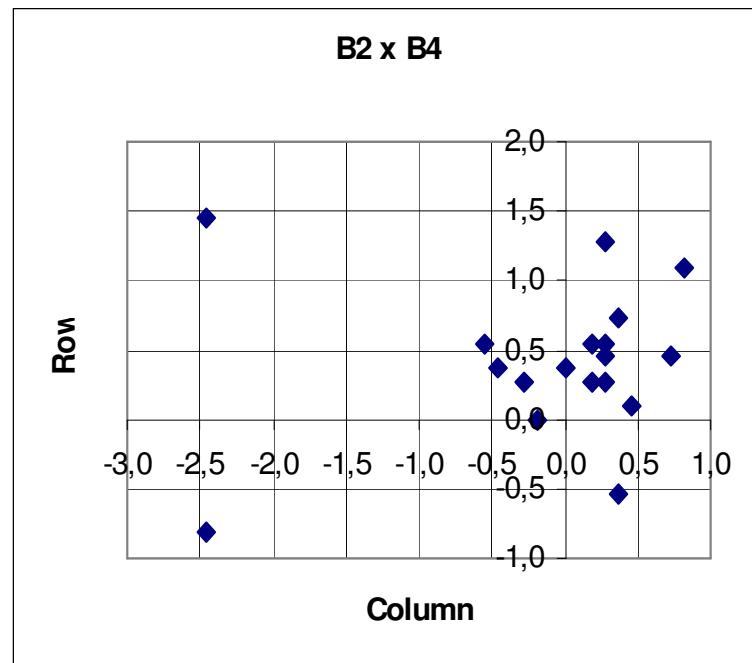
# Band to Band Registration Accuracy

CCD IMAGE	BAND 1	BAND 2	BAND 3	BAND 4
GRAY LEVEL				
GRADIENT (Sobel operator)				



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# Band to Band Registration Accuracy



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# Internal Accuracy

Relative position of pixels with respect to a map projection system

Landsat TM and ETM cameras have established the standards for moderate resolution

Accurate attitude data

A good internal accuracy allows users to easily integrate images, maps, and other geographic data sources



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# Internal Accuracy

## Measurement of control points (CCD, WFI)

Control points are selected manually on CBERS-2B and ortho-rectified (Landsat-7 and CBERS-2) image data

## Geometric transformations

Similarity and orthogonal transformations are used in the assessment

Affine transformation is used only to investigate image registration possibilities

## CBERS processing system produces a report



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# Positioning Accuracy

Global displacement of the image with respect to the earth surface

Landsat-5/7 satellites have established the standards  
Accurate bore-sight, attitude, and ephemeris data

The positioning accuracy defines how far an image is from its true position



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# Positioning Accuracy

Difference between map projection coordinates computed in the geometric correction and actual map projection coordinates

Direct comparison between control points coordinates

CBERS processing system produces a report



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# CCD Internal Accuracy Report

ID	Working Coordinates (m)	Reference Coordinates (m)	Type
1	(549150.00, 7901222.50)	(552831.38, 7897092.04)	Test point
2	(597785.00, 7960402.50)	(601456.72, 7956117.12)	Control point
3	(534989.50, 7925037.75)	(538643.40, 7920913.73)	Test point
4	(546565.67, 7964924.20)	(550214.33, 7960780.09)	Control point
5	(635289.29, 7936915.24)	(639004.11, 7932583.79)	Control point
6	(616233.07, 7906138.86)	(619940.21, 7901854.87)	Test point
7	(528351.06, 7877251.09)	(532066.69, 7873195.83)	Control point
8	(567793.39, 7870765.28)	(571524.14, 7866588.51)	Control point
9	(613890.36, 7871670.64)	(617613.49, 7867411.46)	Control point



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# CCD Internal Accuracy Report

ID	Error_E (m)	Error_N (m)
1	10.20	-54.18
3	55.34	-50.13
6	-11.94	49.65

**Rotation** 0.04

**Orthogonal Transformation Accuracy (RMSE)** 61.16m

**Similarity** 1.00

**Anisomorphism** 0.99

**Lenght Variation** 1.00



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# CCD Internal Accuracy Report

ID	Error_E (m)	Error_N (m)
1	17.91	3.25
3	25.16	18.89
6	9.15	-2.03

**Rotation** 0.04

**Affine Transformation Accuracy (RMSE)** 21.67m

**Similarity** 1.00

**Anisomorphism** 1.00

**Lenght Variation** 1.00



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# CCD Positioning Accuracy Report

Orthogonal Transformation Parameters

**Convergence** YES

**Iterations** 3

**Rotation** 0.04

**Positioning Error\_E** 228.4 meters

**Positioning Error\_N** 963.5 meters

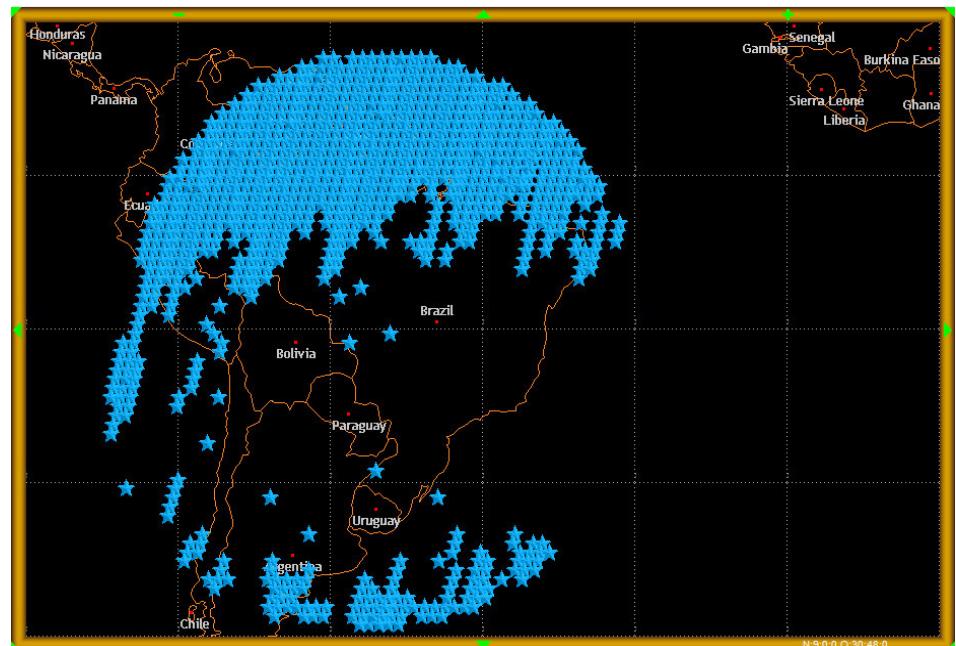
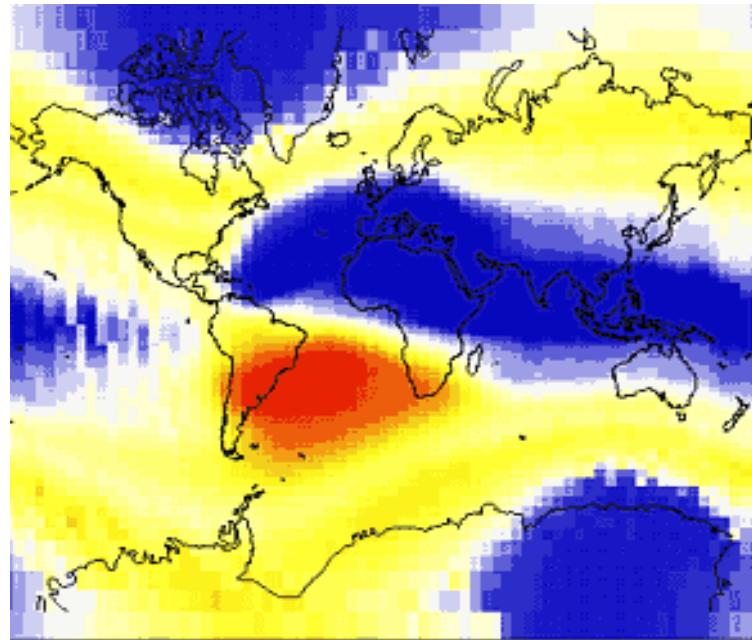


Geolocation



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# SAA and CBERS-2B Star Sensor



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# Final Remarks on Geometric Quality

CBERS-2B positioning accuracy lies within  
300m (easting) and 1,000m (northing)  
TLE for ephemeris and AOCS for attitude data

CCD internal accuracy is around 4 pixels

Residual skew is caused by inaccurate attitude (yaw)  
This skew is easily modeled by an affine transformation

WFI internal accuracy is around 2 pixels

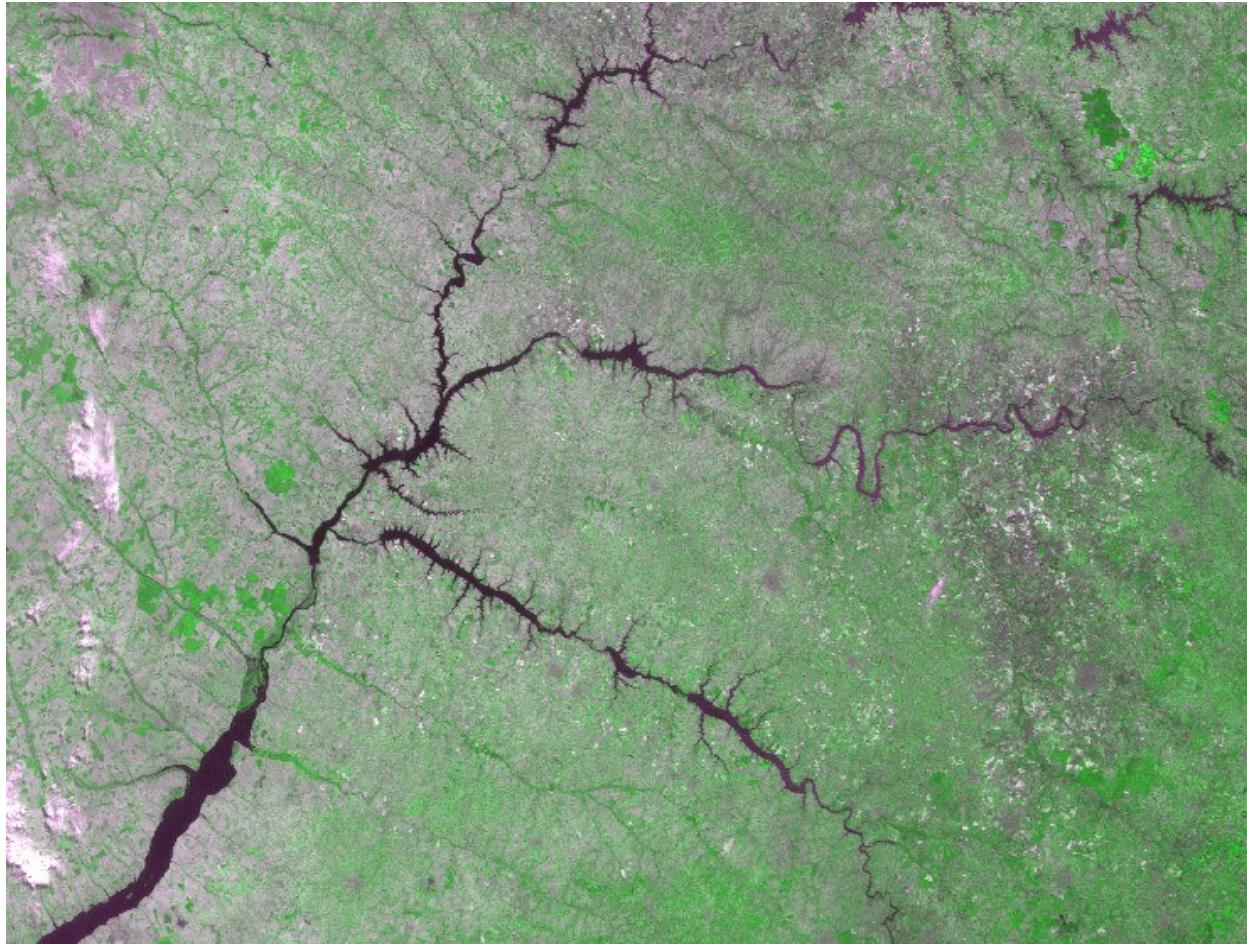


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# WFI over Southeastern Brazil



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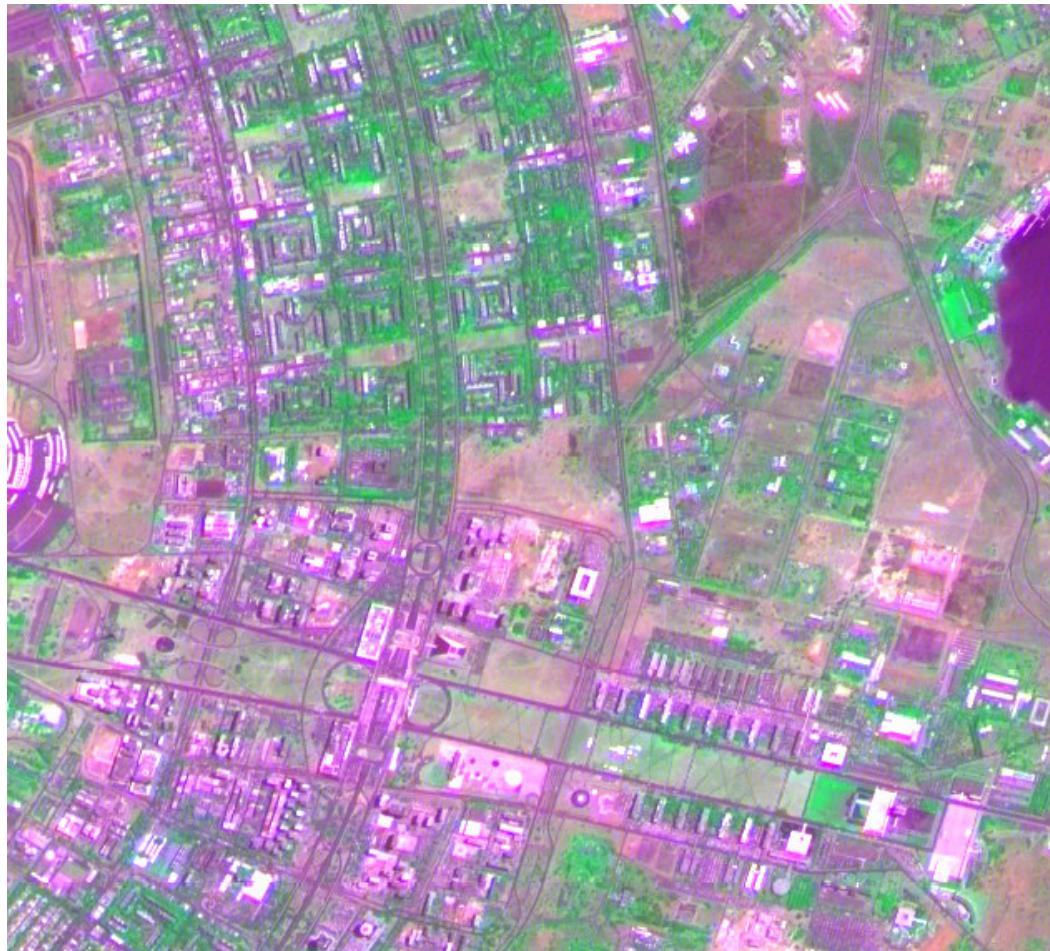
# CCD over Southeastern Brazil



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# Brasilia: HRC + CCD



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# HRC over Buenos Aires



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# CBERS-2B

## Radiometric and Geometric Quality Assessment

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**Thanks!**



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