MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Agency Report
National Institute for Space Research – INPE
Brazil

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WGISS/CEOS – 42 Meeting, September 2016, Frascati, Italy

INPE: CONVERTING DATA INTO KNOWLEDGE

SATELLITES

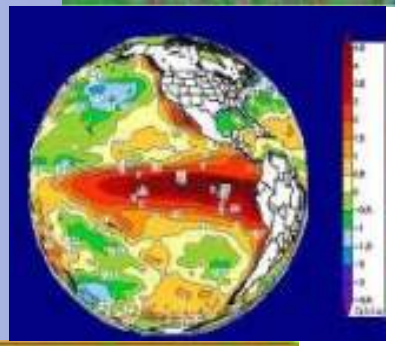
Earth observation, scientific,
and data collection satellites

GROUND SYSTEMS

Satellite control, reception, processing
and distribution of satellite data

ANALYSIS AND MODELLING

Space Weather, Weather Prediction
and Earth System Science



SOCIETAL BENEFITS

Innovative products
to meet Brazil´s needs

Fostering the concept of public-good data

Brazil, 2004	INPE set a free data policy for CBERS in Brazil CBERS data available free of charges on the Web Impacts on EO consulting and services in Brazil Increasing EO data distribution for society
South Africa, 2007	Announcement of the CBERS for Africa Initiative Extension of CBERS free data policy for Africa
America, 2008	USGS adopted a free data policy for Landsat Landsat image data also available free of charges
Europe, 2009	ESA announced a free data policy for Sentinels

CBERS Program - Status

CBERS-3 was lost after a failure in the last stage of the launching rocket in 2013.

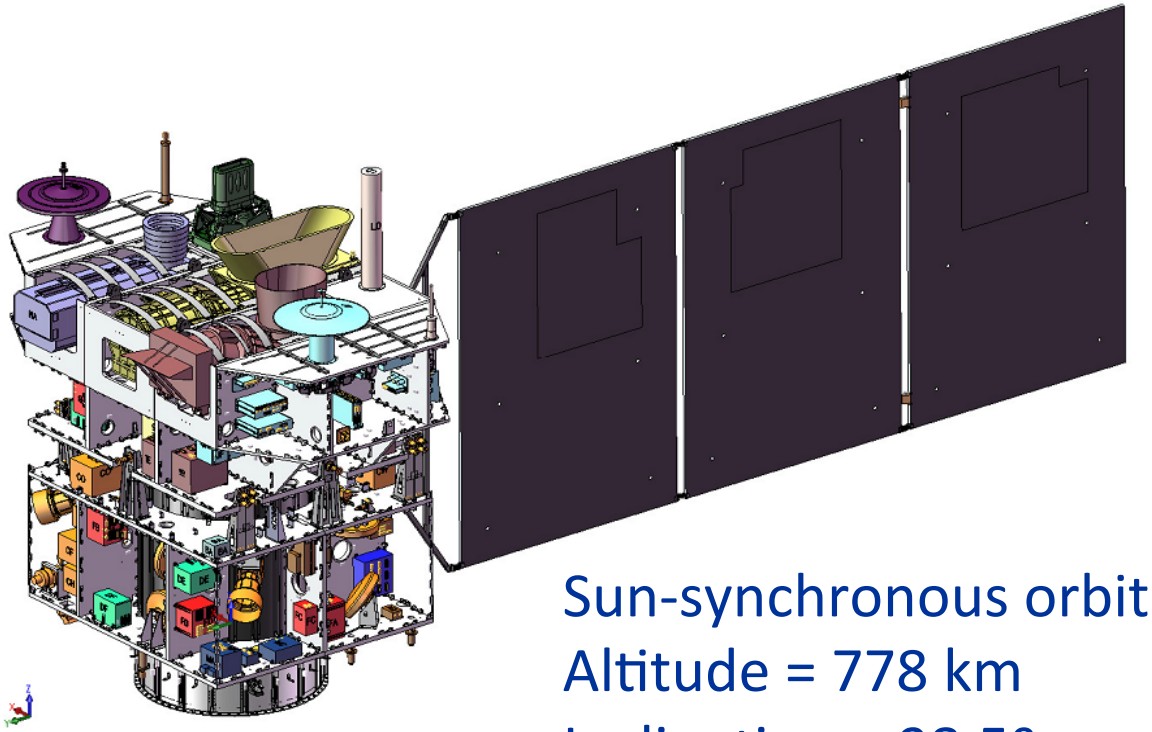
CBERS-4 was successfully launched in December 2014.

CBERS-4 images have been regularly acquired in Cuiabá.

Commissioning phase was executed from December 2015 to May 2016 to assess and validate CBERS-4 cameras.

Images are available on the web (www2.dgi.inpe.br/CDSR).

CBERS 3 & 4 – 2nd generation series



Sun-synchronous orbit
Altitude = 778 km
Inclination = 98.5º
Nodal period = 100.26 minutes
Repeat cycle = 26 days
Descending node at 10h30 local time

CBERS 3 & 4 – 2nd generation series

Parameter	CBERS 1, 2, 2B	CBERS 3, 4
Total mass	1,450 kg	2,020 kg
Power	1,100 W	2,300 W
Data rate	100 Mbit/s	305 Mbit/s
Design lifetime	2 years	3 years

CBERS 3 & 4 – cameras

Payloads	MUX	PAN	IRS	WFI
Manufacturer	Brazil	China	China	Brazil
Type	Pushbroom	Pushbroom	Scanner	Pushbroom
Revisit time	26 days	52 days (nadir operation) side looking (32 degrees)	26 days	5 days
Quantization	8 bits	8 bits	8 bits	10 bits
Data rate	68 Mbits/s	67, 100 Mbits/s	17 Mbits/s	53 Mbits/s
Compression		2:1 pan band		

CBERS 3 & 4 – cameras

Payloads	MUX	PAN	IRS	WFI
Band 1	0.45 - 0.52 µm	0.51 - 0.73 µm	0.77 - 0.89 µm	0.45 - 0.52 µm
Band 2	0.52 - 0.59 µm	0.52 - 0.59 µm	1.55 - 1.75 µm	0.52 - 0.59 µm
Band 3	0.63 - 0.69 µm	0.63 - 0.69 µm	2.08 - 2.35 µm	0.63 - 0.69 µm
Band 4	0.77 - 0.89 µm	0.77 - 0.89 µm	10.4 - 12.5 µm	0.77 - 0.89 µm
Resolution	20 m	5 m, 10 m	40 m, 80 m	70 m
Swath width	120 km	60 km	120 km	866 km

Basic processing levels of CBERS-4

L0: raw image data.

L1: radiometrically corrected images.

L2: L1 plus geometric system-correction.

L3: L2 plus registration through ground control points.

L4: L2 plus registration through ground control points and terrain correction (orthorectification).

L3 and **L4** are processed automatically by means of image correlation techniques and geometric transformations.

Internal accuracy estimation for MUX

Points	Scenes	L4 RMSE (m)	L4 RMSE σ	L2 CT Scale	L2 CT Scale σ	L2 AT Scale	L2 AT Scale σ
> 50	330	12.112	2.165	1.0002	0.0011	1.0000	0.0002
> 40	489	11.981	2.247	1.0002	0.0012	1.0000	0.0002
> 30	686	12.192	2.676	1.0001	0.0013	1.0000	0.0002
> 20	996	12.154	2.944	1.0001	0.0014	1.0000	0.0006

Ground control points extracted from terrain-corrected (orthorectified) Landsat-8 images

RMSE: root mean square error; σ: standard deviation; CT: across-track; AT: along-track

Internal accuracy estimation for MUX

Points	Scenes	L3 RMSE (m)	L3 RMSE σ	L2 CT Scale	L2 CT Scale σ	L2 AT Scale	L2 AT Scale σ
> 50	15	18.277	3.229	1.0004	0.0005	0.9999	0.0002

Points	Scenes	L2 RMSE After translation (m)	L2 RMSE After translation σ
> 50	386	30.427	28.931

Ground control points extracted from terrain-corrected (orthorectified) Landsat-8 images

RMSE: root mean square error; σ: standard deviation; CT: across-track; AT: along-track

Internal accuracy estimation for WFI

Points	Scenes	L4 RMSE (m)	L4 RMSE σ	L2 CT Scale	L2 CT Scale σ	L2 AT Scale	L2 AT Scale σ
> 200	4	62.014	3.446	0.9993	0.0005	1.0000	0.0000
> 150	5	61.227	3.416	0.9994	0.0005	1.0000	0.0000
> 100	8	62.256	3.198	0.9995	0.0004	1.0000	0.0000
> 50	13	63.089	4.461	0.9994	0.0004	1.0000	0.0001

Ground control points extracted from subsampled terrain-corrected Landsat-8 images

RMSE: root mean square error; σ: standard deviation; CT: across-track; AT: along-track

Internal accuracy estimation for WFI

Points	Scenes	L3 RMSE (m)	L3 RMSE σ	L2 CT Scale	L2 CT Scale σ	L2 AT Scale	L2 AT Scale σ
> 50	11	72.116	27.360	1.0015	0.0034	1.0000	0.0001

Points	Scenes	L2 RMSE After translation (m)	L2 RMSE After translation σ
> 150	21	184.197	103.466

Ground control points extracted from subsampled terrain-corrected Landsat-8 images

RMSE: root mean square error; σ: standard deviation; CT: across-track; AT: along-track

Internal accuracy estimation for PAN5

Points	Scenes	L4 RMSE (m)	L4 RMSE σ	L2 CT Scale	L2 CT Scale σ	L2 AT Scale	L2 AT Scale σ
> 50	51	13.060	2.157	1.0001	0.0028	1.0000	0.0001
> 40	66	12.997	2.072	1.0002	0.0028	1.0000	0.0001
> 30	82	12.806	2.113	1.0004	0.0026	1.0000	0.0001
> 20	105	12.899	2.223	1.0002	0.0028	1.0000	0.0001

Ground control points extracted from terrain-corrected (orthorectified) RapidEye images

RMSE: root mean square error; σ: standard deviation; CT: across-track; AT: along-track

Internal accuracy estimation for PAN5

Points	Scenes	L3 RMSE (m)	L3 RMSE σ	L2 CT Scale	L2 CT Scale σ	L2 AT Scale	L2 AT Scale σ
> 20	7	11.346	1.810	1.0023	0.0003	1.0000	0.0000

Points	Scenes	L2 RMSE After translation (m)	L2 RMSE After translation σ
> 50	52	46.731	12.797

Ground control points extracted from terrain-corrected (orthorectified) RapidEye images

RMSE: root mean square error; σ: standard deviation; CT: across-track; AT: along-track

Internal accuracy estimation for PAN10

Points	Scenes	L4 RMSE (m)	L4 RMSE σ	L2 CT Scale	L2 CT Scale σ	L2 AT Scale	L2 AT Scale σ
> 50	120	15.340	2.362	1.0001	0.0026	1.0000	0.0001
> 40	141	15.194	2.517	1.0000	0.0026	1.0000	0.0001
> 30	164	15.249	2.564	1.0000	0.0027	1.0000	0.0001
> 20	194	15.193	2.701	1.0000	0.0027	1.0000	0.0001

Ground control points extracted from terrain-corrected (orthorectified) RapidEye images

RMSE: root mean square error; σ: standard deviation; CT: across-track; AT: along-track

Internal accuracy estimation for PAN10

Points	Scenes	L3 RMSE (m)	L3 RMSE σ	L2 CT Scale	L2 CT Scale σ	L2 AT Scale	L2 AT Scale σ
> 20	7	17.822	3.661	0.9963	0.0003	1.0002	0.0001

Points	Scenes	L2 RMSE After translation (m)	L2 RMSE After translation σ
> 50	130	45.037	18.087

Ground control points extracted from terrain-corrected (orthorectified) RapidEye images

RMSE: root mean square error; σ: standard deviation; CT: across-track; AT: along-track

Internal accuracy estimation for IRS

Points	Scenes	L4 RMSE (m)	L4 RMSE σ	L2 CT Scale	L2 CT Scale σ	L2 AT Scale	L2 AT Scale σ
> 50	2	29.787	1.592	0.9981	0.0009	0.9963	0.0000
> 40	4	34.376	5.222	0.9994	0.0015	0.9960	0.0005
> 30	6	34.556	4.272	1.0001	0.0015	0.9959	0.0004
> 20	10	34.008	4.238	1.0001	0.0013	0.9960	0.0005

Ground control points extracted from terrain-corrected (orthorectified) Landsat-8 images

RMSE: root mean square error; σ: standard deviation; CT: across-track; AT: along-track

Internal accuracy estimation for IRS

Points	Scenes	L3 RMSE (m)	L3 RMSE σ	L2 CT Scale	L2 CT Scale σ	L2 AT Scale	L2 AT Scale σ
> 5	11	43.648	11.795	0.9999	0.0015	1.0003	0.0030

Points	Scenes	L2 RMSE After translation (m)	L2 RMSE After translation σ
> 50	2	146.455	9.155

Ground control points extracted from terrain-corrected (orthorectified) Landsat-8 images

RMSE: root mean square error; σ: standard deviation; CT: across-track; AT: along-track

Summarizing

MUX L4 images are suitable for mapping at scales 1:50,000 and smaller.

WFI L4 images are suitable for mapping at scales 1:250,000 and smaller.

PAN5 and PAN10 L4 images are suitable for mapping at scales 1:50,000 and smaller.

IRS L4 images are suitable for mapping at scales 1:100,000 and smaller.

These conclusions are based on the comparison of resulting RMSEs with commonly accepted cartographic standards.

Summarizing

MUX L4 images are extremely consistent in time in terms of their geometric internal accuracies.

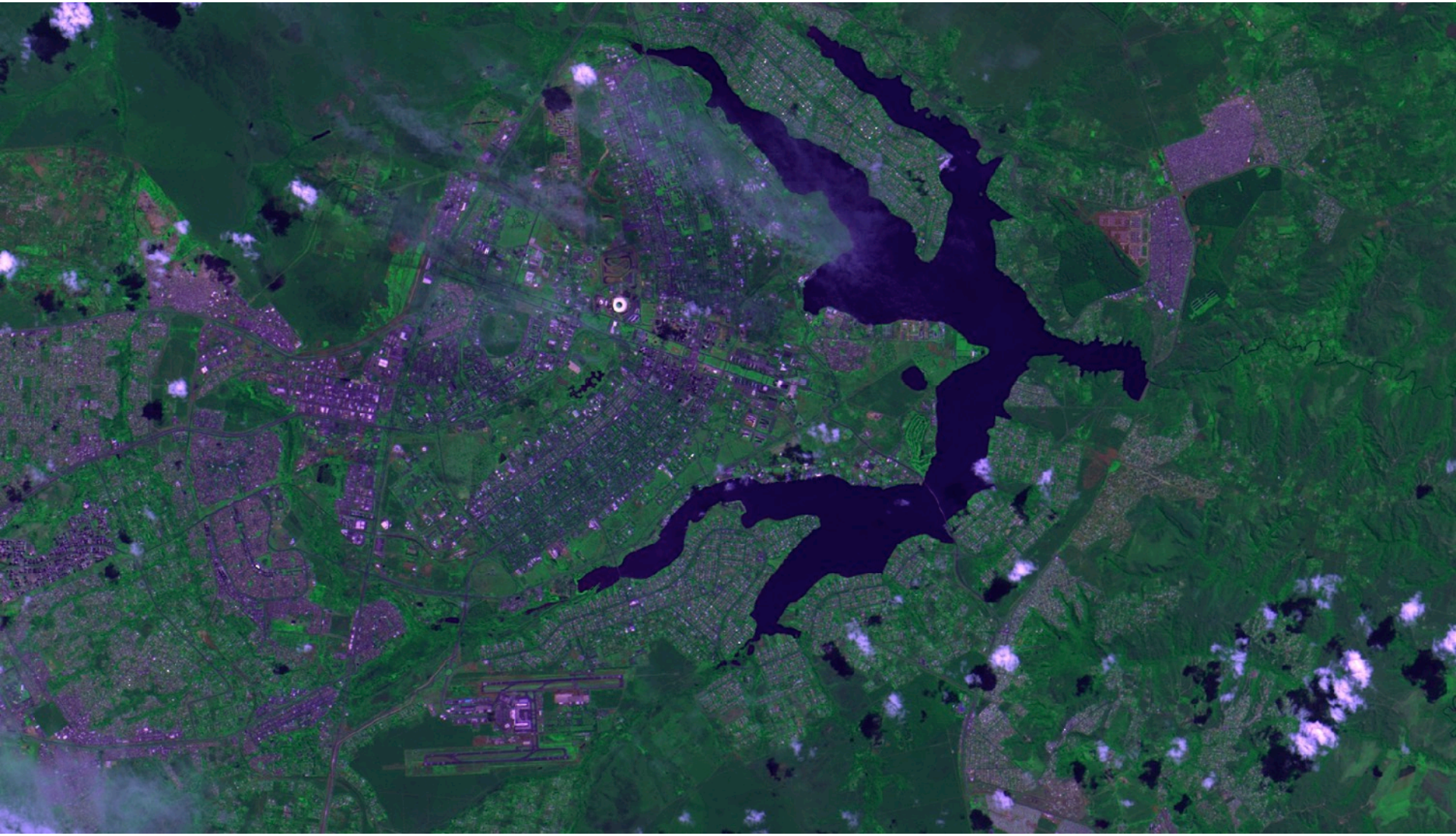
Although WFI L4 images have acceptable geometric internal accuracies, a refinement in the optical distortion model of the two optical systems of the camera is still being analyzed.

PAN5 and PAN10 L4 images have acceptable geometric internal accuracies that are about to be improved by the application of optical distortion models provided recently by our Chinese partners.

IRS L4 geometric internal accuracies are not as acceptable as it should be, as a result of inaccurate modeling of its camera push broom system.

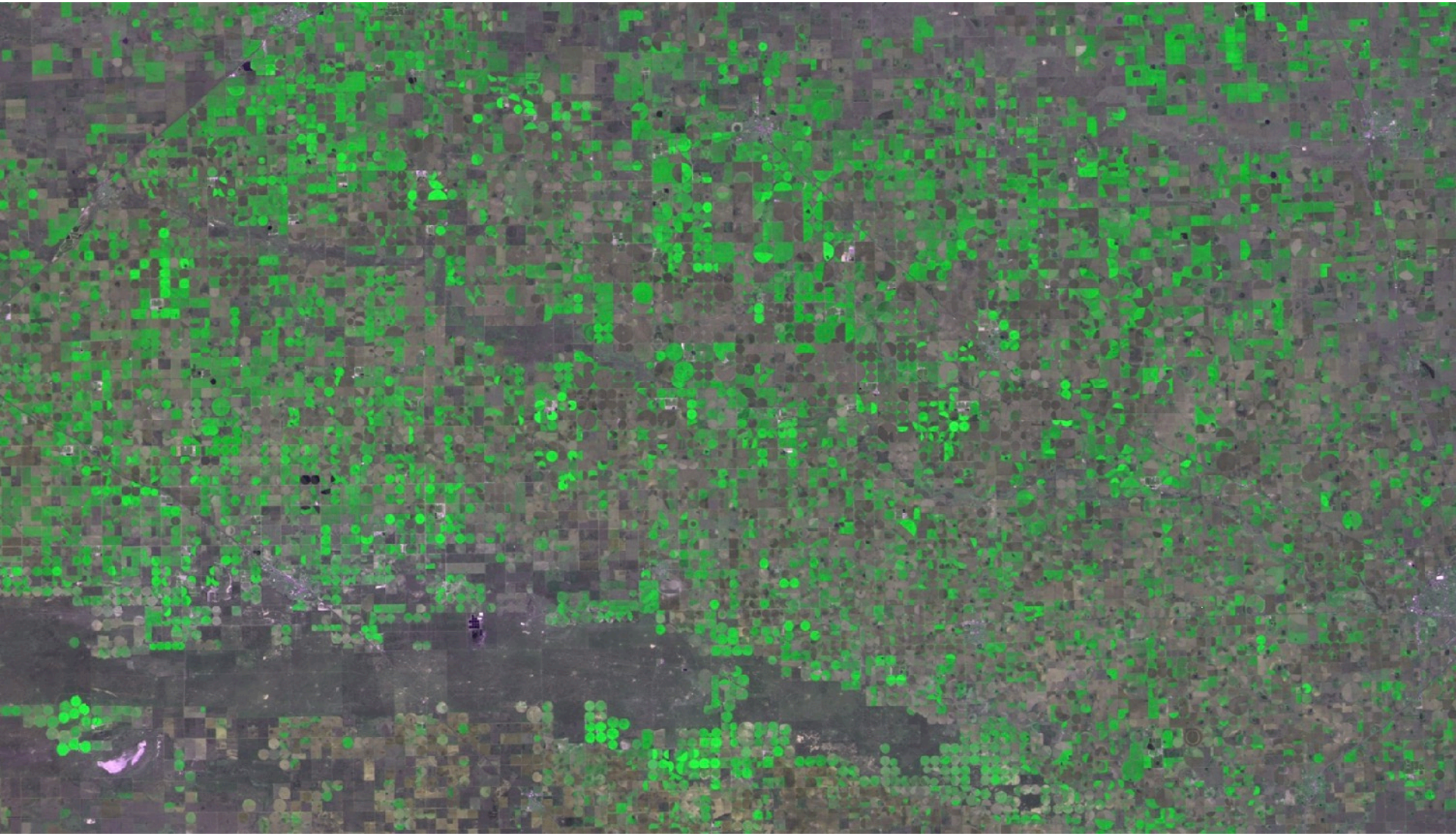
SOME IMAGES

Brasilia, DF, Brazil - MUX

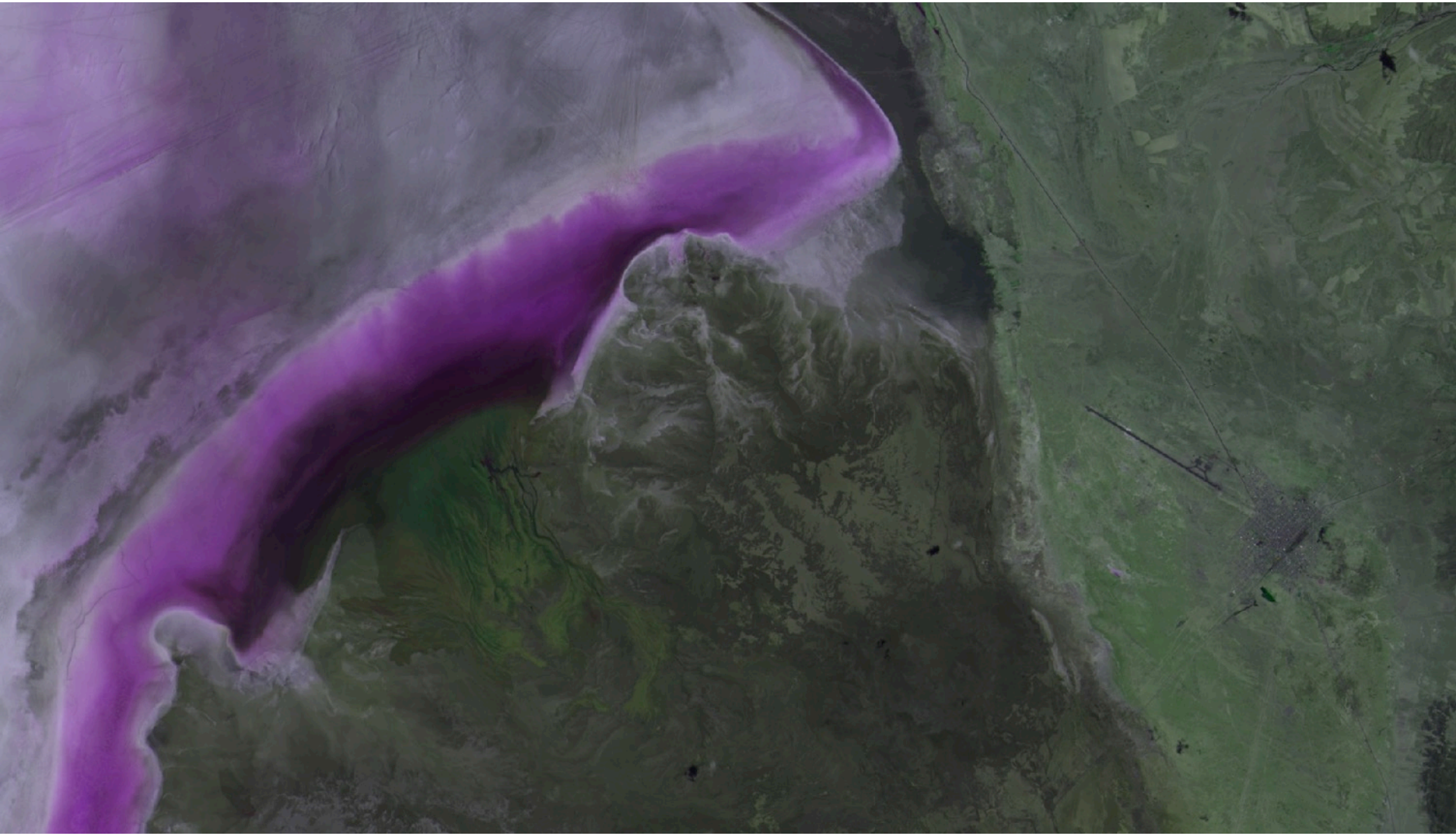


Rio de Janeiro, RJ, Brazil - PAN -10

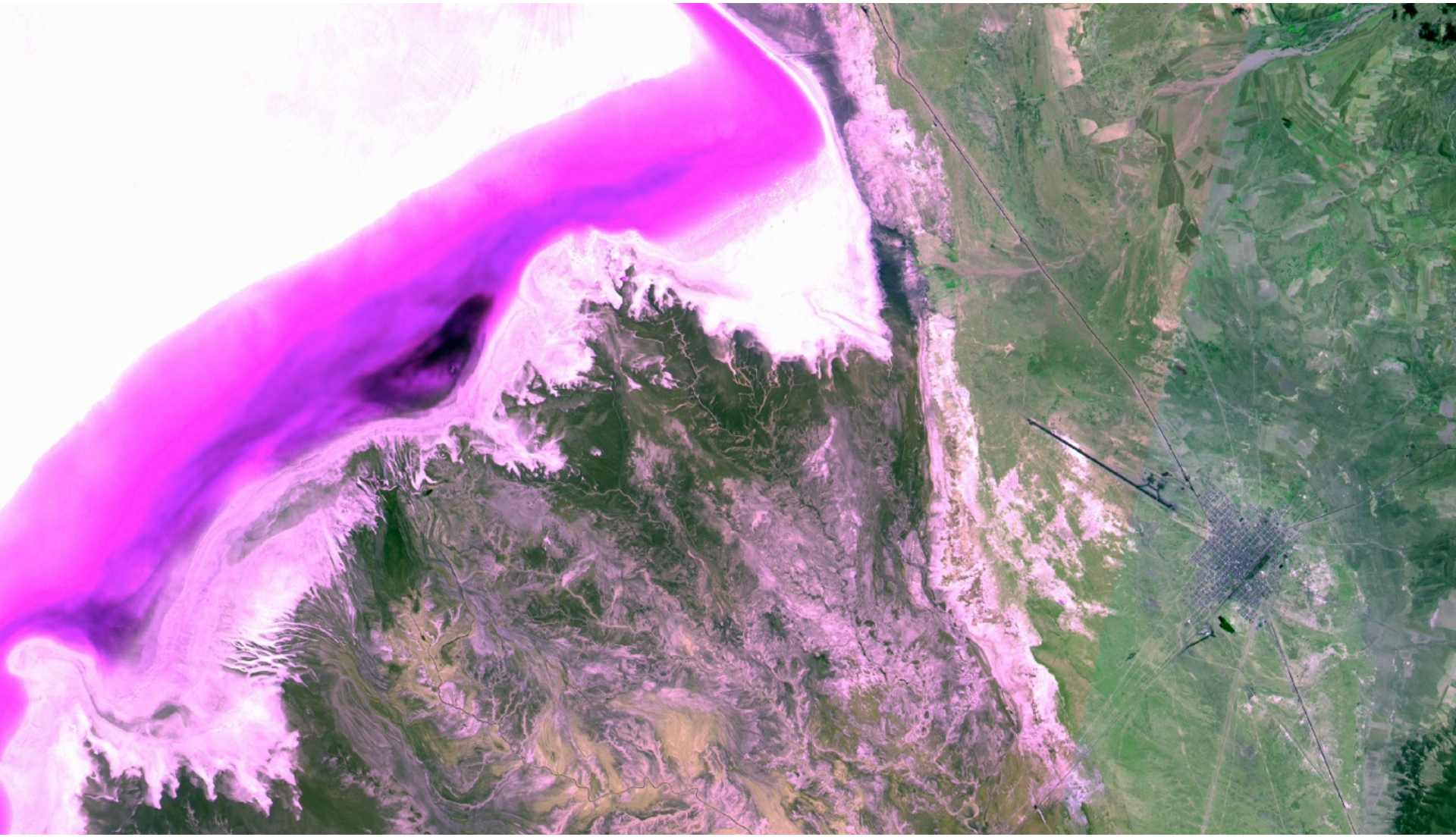
EUA – WFI



Uyuni Salar, Chile – WFI

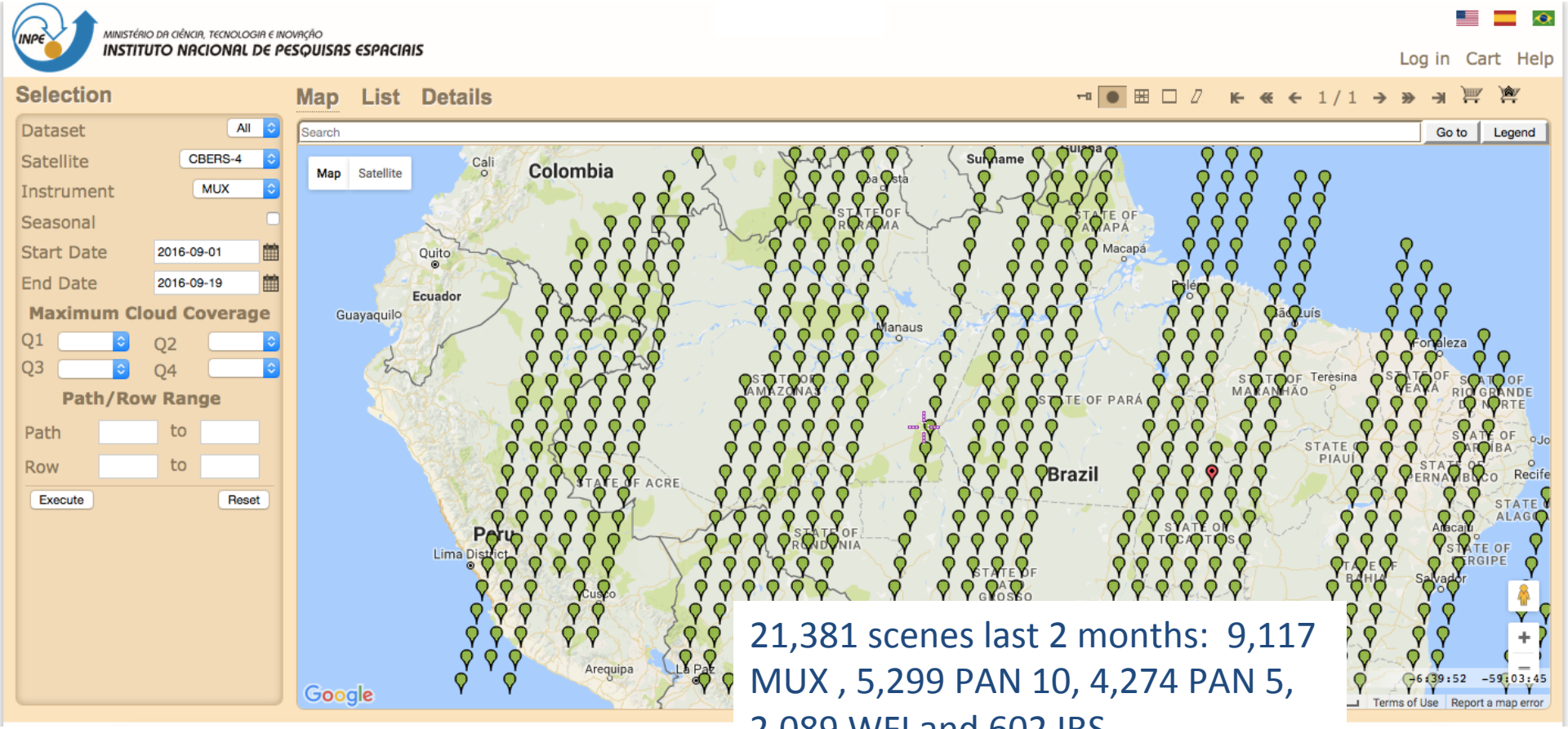


Uyuni Salar, Chile – Pan 10



Distribution

Images are available on the web (www2.dgi.inpe.br/CDSR).



21,381 scenes last 2 months: 9,117 MUX , 5,299 PAN 10, 4,274 PAN 5, 2,089 WFI and 602 IRS

Distribution

PHP access API to support CWIC connector

www.dgi.inpe.br/cwic_cb4/latlong.php?dataset=INPE_CBERS4_MUX&north=-22.5&south=-23.5&east=-45.5&west=-46.5

Mais visitados Primeiros passos OS Scene

O documento XML não está associado a estilos. A estrutura do documento está representada abaixo.

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Discovery

OpenSearch prototype implementation

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xmlns:geo="http://a9.com/-/opensearch/extensions/geo/1.0/"
xmlns:time="http://a9.com/-/opensearch/extensions/time/1.0/">
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    <Description>INPE -- National Institute for Space Research granule search using
        OpenSearch Geo and Time extensions</Description>
    <Tags>INPE granule</Tags>
    <Contact>atus@dgi.inpe.br</Contact>
    <Url type="application/atom+xml" template="{{ url }}atom/granule?bbox={geo:box?}
    &amp;searchTerms={searchTerms}&amp;
    count={count?}&amp;startIndex={startIndex?}&amp;start={time:start}&amp;end={time:end}"/>
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    count={count?}&amp;startIndex={startIndex?}&amp;start={time:start}&amp;end={time:end}"/>
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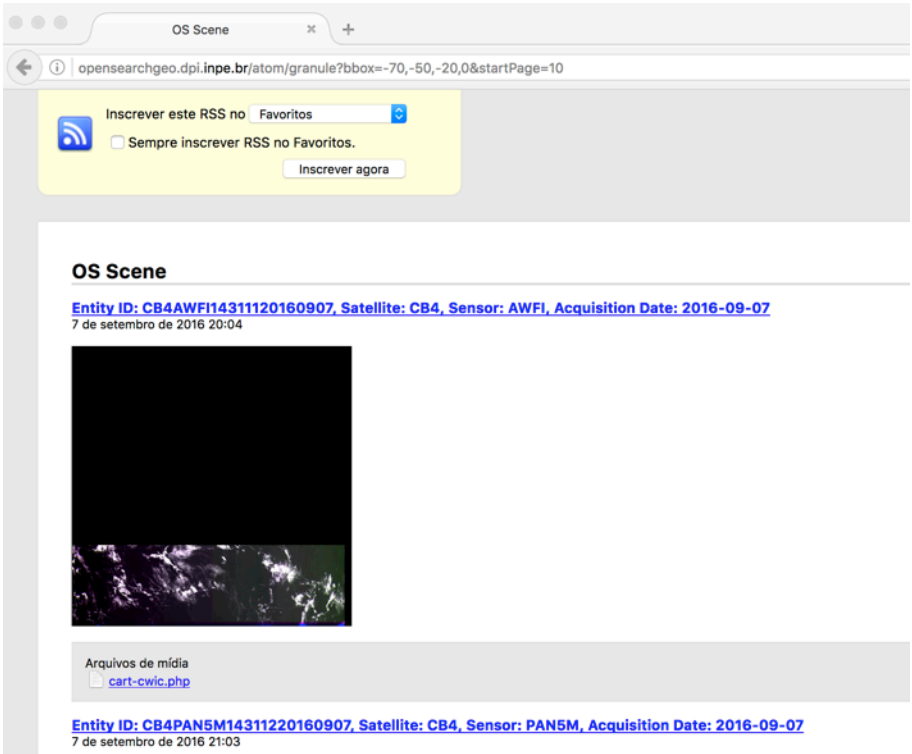
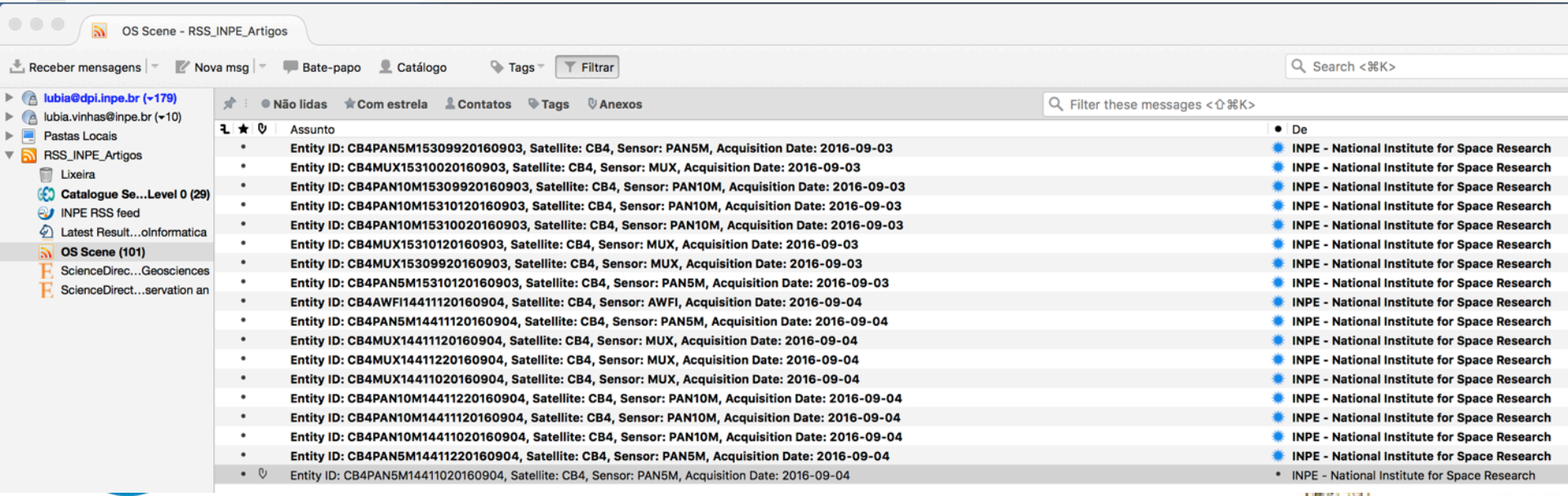
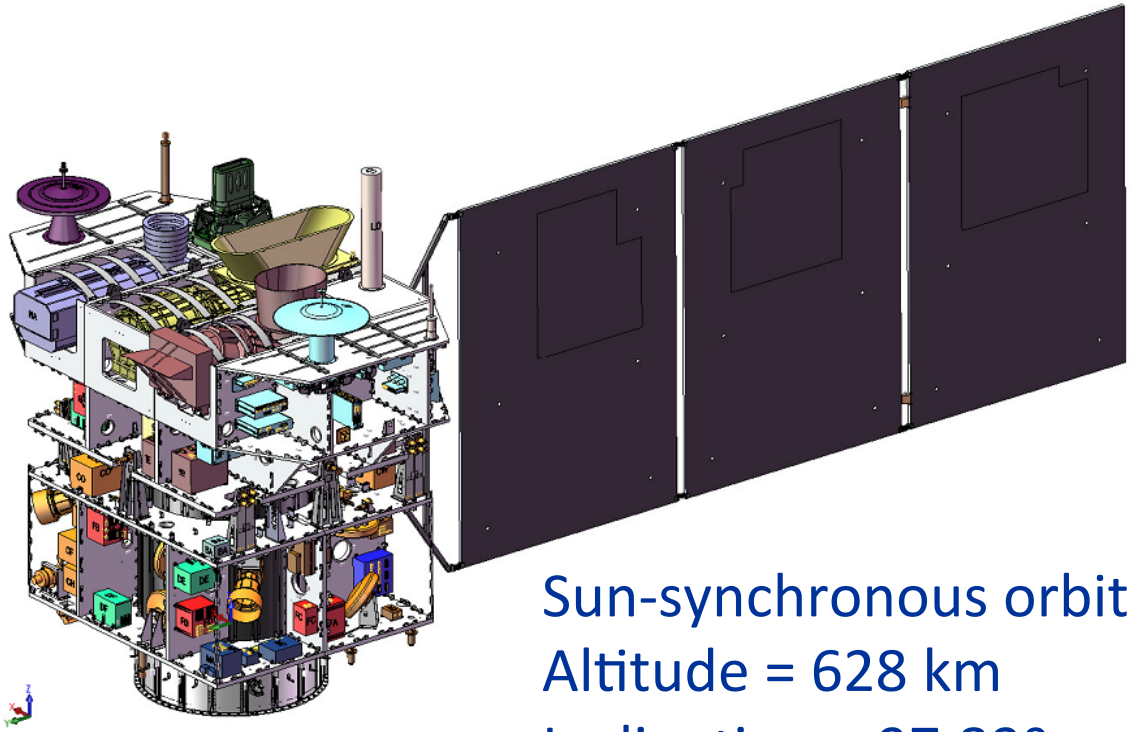
OpenSearch prototype implementation





CBERS 4A – equipment reuse



Sun-synchronous orbit
Altitude = 628 km
Inclination = 97.89º
Repeat cycle = 31 days
Descending node at 10h30 local time
Launching: 2018

CBERS 4A – cameras

Payloads	MUX	WPM	WFI
Manufacturer	Brazil	China	Brazil
Type	Pushbroom	Pushbroom TDI	Pushbroom
Revisit time	31 days	31 days	5 days
Quantization	8 bits	10 bits	10 bits
Swath width	95 km	92 km	684 km

CBERS 4A – cameras

Payloads	MUX	WPM	WFI
Band 1	0.45 - 0.52 µm	0.45 - 0.52 µm	0.45 - 0.52 µm
Band 2	0.52 - 0.59 µm	0.52 - 0.59 µm	0.52 - 0.59 µm
Band 3	0.63 - 0.69 µm	0.63 - 0.69 µm	0.63 - 0.69 µm
Band 4	0.77 - 0.89 µm	0.77 - 0.89 µm	0.77 - 0.89 µm
Band 5 (PAN)		0.45 - 0.90 µm	
Resolution	16 m	2 m, 8 m	55 m

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