INPE Report to WGCV-35

WGCV 35 WGISS 34 joint meeting
Hosted by ISRO and NRSC, Hyderabad
24-28 September

Leila Fonseca
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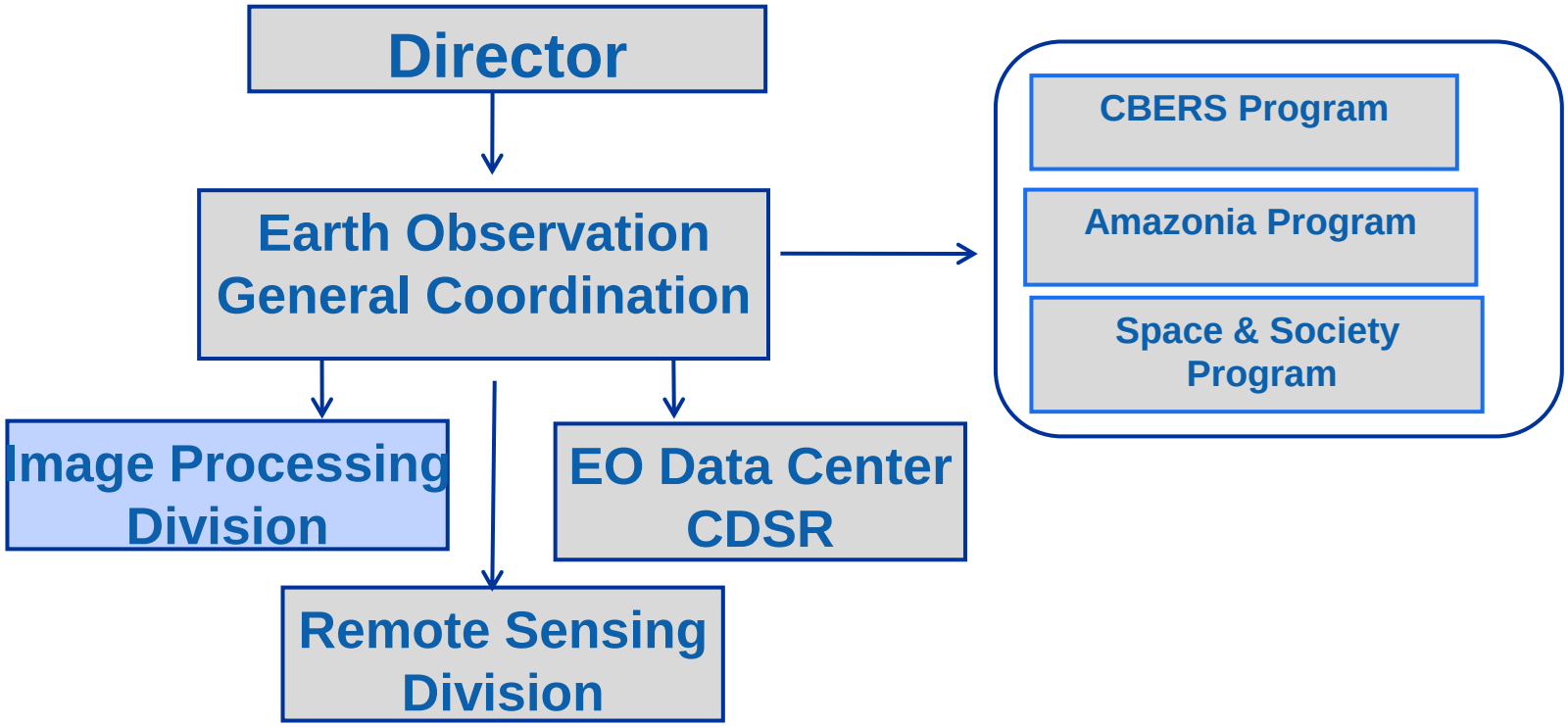
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

EO internal hierarchical structure



Director: Dr. Leonel Fernando Perondi, he has been working at INPE since 1982, General Coordinator of Space Engineering and Technology (2002-2004), CBERS Program Manager (2002-2005), and vice Director (2001-2005)

INPE's agenda in multilateral agreements

CEOS

INPE was the CEOS chair in 2010
Participation in WGCV (Leila Fonseca e Flavio Ponzoni)
Participation in WGISS (Lubia)
INPE is the current Chair of the WGCapD (Hilcea Ferreira)
INPE is co-chair of the LSI (Julio DAlge, with USGS and ISRO)
INPE has a scientific participation in PC (Luiz Augusto Machado)
INPE has a scientific participation in OCR (Milton Kampel)

GEO

INPE represents Brazil in GEO
INPE participates in CB and IDTT GEO Tasks
INPE participates in CB for Disaster Management
INPE participates in CB in CBERS for Africa
INPE leads IDTT Open Source Software Tools (GEO ID-02)
INPE and CRESDA lead IDTT CBERS for Africa

DMCii

dmc International Imaging

Earth Observation Solutions

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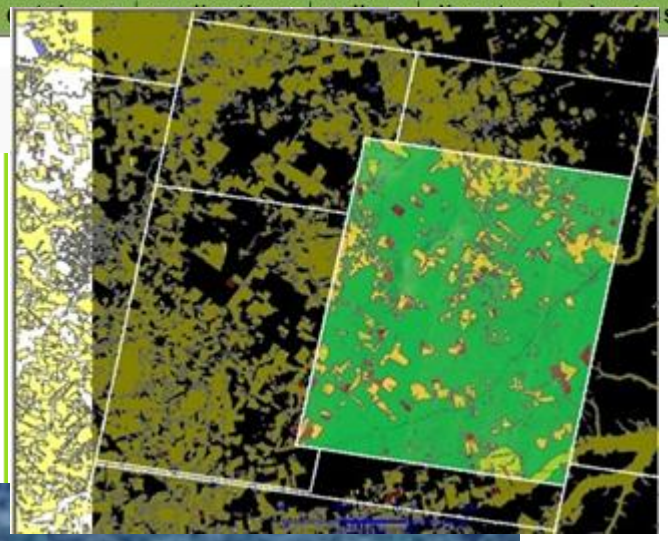
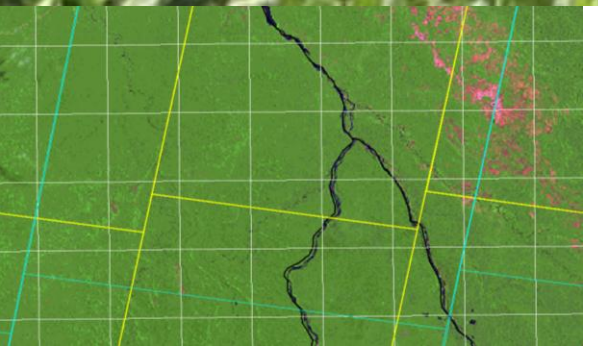
Thu, 13 Sep 2012 16:00:16

DMCii's detailed satellite imagery helps Brazil stamp out deforestation as it happens

Remote sensing solutions provider DMC International Imaging Ltd (DMCii) has signed a contract with Brazil's National Institute for Space Research (INPE) to deliver near real-time satellite imagery to monitor forest clearing in the Amazon rainforest and target illegal logging as it happens.

INPE is leading the world in the use of satellite imagery to monitor deforestation, providing information central to Brazil's war on deforestation that has cut





INPE's agenda in bilateral agreements

China

CBERS-1, CBERS-2, and CBERS-2B
CBERS-3 and CBERS-4
Ground and application segment with CRESDA
Planning of CBERS-5 and CBERS-6

United States

Joint mission with JPL hyperspectral camera
Using INPE's Multi Mission Platform (MMP)

United Kingdom

Reception of UK-DMC2 at INPE's ground station
Partnership with DMCii for forest monitoring

India

Reception of ResourceSat-1 LISS-3 and AWiFS
Agreement with ISRO for receiving ResourceSat-2

CBERS-3/4 payload overview

Sensors	Resolution	Bands	Swath (Km)	Revisit (days)	bits/pixel
MUX	20 m	B, G, R, NIR	120	26	8
PAN	5 m 10m	PAN G, R, NIR	60 off nadir (32^o)	52 *	8
WFI	73 m	B, G, R, NIR	866	5	10
IRS	40m 80m	NIR, MIR, TIR	120	26	8

Onboard recorder for MUX, PAN, IRS and WFI

(*) Mirror may be used to revisit the same place within 3 days if necessary

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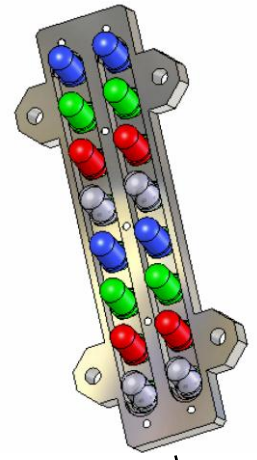
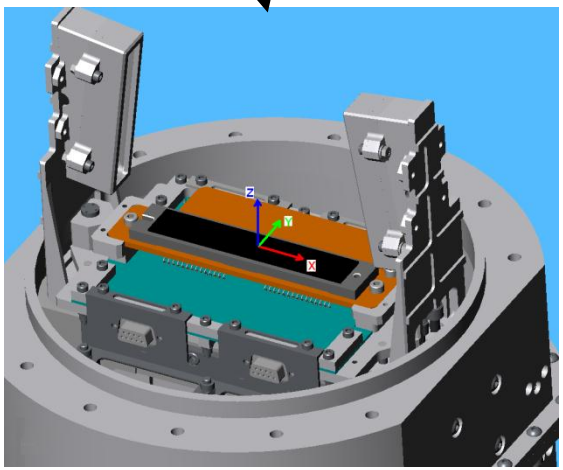
CBERS 3 launch schedule

- Failures in some DC/DC converters (MDI - Modular Devices Incorporated, USA) on the satellite power system was detected during tests in China
- CBERS-3 will be launched from China using a Long March rocket in the beginning of 2013 (February)

CBERS-3 MUX and WFI: Radiometry evaluation

- OPTO Eletronica S/A built and evaluated WFI and MUX cameras
- onboard LED internal calibration for evaluation of response degradation
- Distinct LED groups for each spectral band
- Evaluation of response linearity, noise performance,
  Saturation, response Linearity,
  noise performance, radiance saturation





Câmera MUX Câmera WFI

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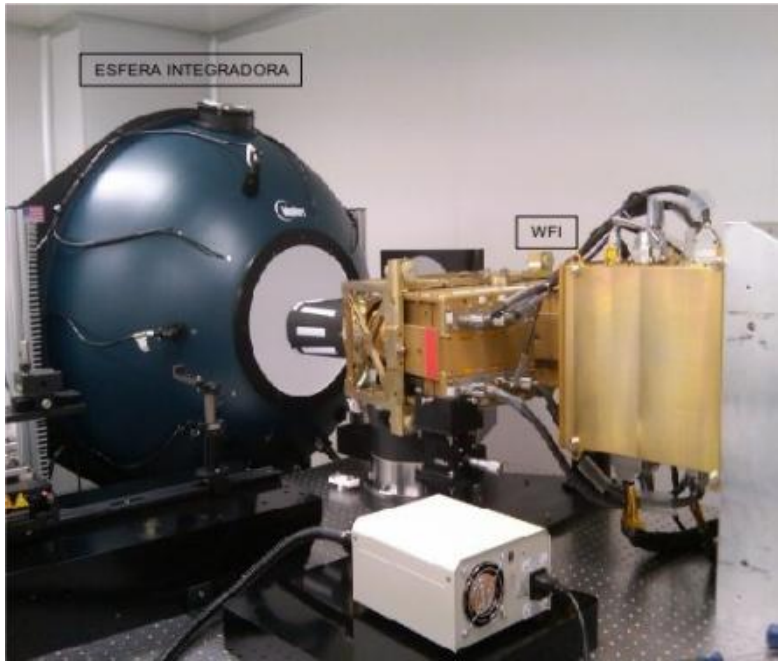
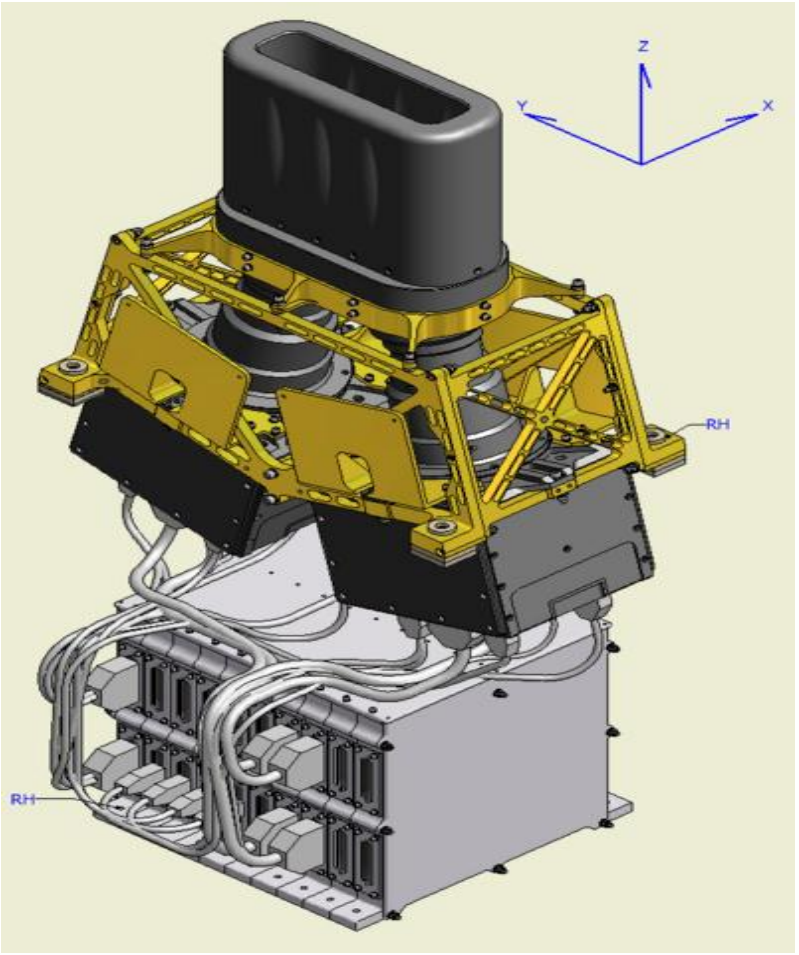
IC Procedure

- Relative and absolute calibrations were performed in the lab, prior launch, with an integrating sphere
  - Generate an initial set of gains and offsets for each detector
- Calibration data are acquired and stored as “reference images”(8 illumination levels)
- On board IC data is compared to the reference image
  - Differences are modeled by multiplicative coefficients adjustments for each detector´s gain
- Calibration coefficients will be updated through vicarious calibration campaigns

Wide Field Imager Calibration

- **Calibration similar to MUX calibration**
  - One IC assembly for each focal plane
- **Cross-calibration between MUX and WFI for validation**





CBERS data processing and distribution

- AMS Kepler S/A has developed the ground image processing station (MS3) for CBERS
- Ground system processing is being extended to use GPU (Graphic Processing Unit**)**
- AMS Kepler S/A will deliver, as metadata, the coefficients to transform digital numbers to radiance for each band
  - Initially based on lab and internal calibration,
  - Updates will be performed from vicarious calibration campaigns
- Planning radiometric calibration campaign in the Gobi Desert, China, by June 2013
- Data distribution under free data policy
- The CDSR (Data Center) is already prepared to receive and distribute the CBERS3 images

Amazonia 1 – Advanced Wide Field Imaging camera (AWFI)

Parameter	AWFI
Band 1	0.45 - 0.52 µm
Band 2	0.52 - 0.59 µm
Band 3	0.63 - 0.69 µm
Band 4	0.77 - 0.89 µm
Resolution	40 m
Swath width	700 km
Revisit time	5 days

Parameter	AWFI
Radiom resolution	10 bits
MTF (bands 1-3)*	≤ 0.23
MTF (band 4)*	≤ 0.18
On board recorder	15 min/orbit
B2B registration	< 0.3 pixels
Abs. calib. accuracy	> 10%
Relative cal	> 3%

Planned to be launched in 2014

Real-time capability in each pass of ≈ 15 minutes

(*) across-track MTF at Nyquist frequency (38.5 lp/mm)

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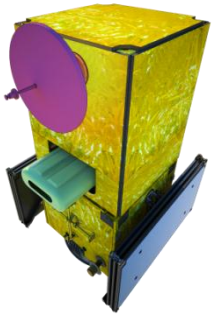
Amazonia 1 – AWFI camera

- The main goal of Amazonia 1 is to provide image data to monitor deforestation especially in the Amazon region, with a high revisit period
- The remote sensing Amazonia mission is the first mission to use the Multi-Mission Platform (MMP) developed by INPE, and support a variety of low Earth orbit missions with different payload instruments
- New products will provided:
  - Mosaics of “MODIS style” composite images (1 cycle: 5 days, 3 cycles: 15 days and 6 cycles: 30 days)
  - Land change detection Maps

MMP satellites and scientific missions

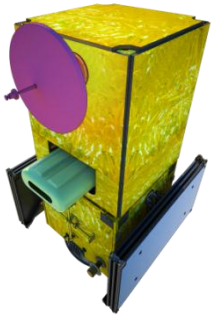


AMZ 1

First MMP mission

Forest monitoring

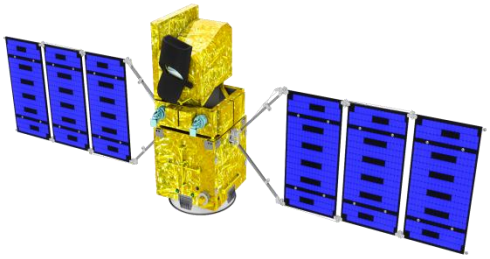
Launch date: 2014



AMZ 1B

Forest monitoring

Launch date: 2015



GTEO

Scientific INPE/JPL (hyperspectral)

Launch date: 2016

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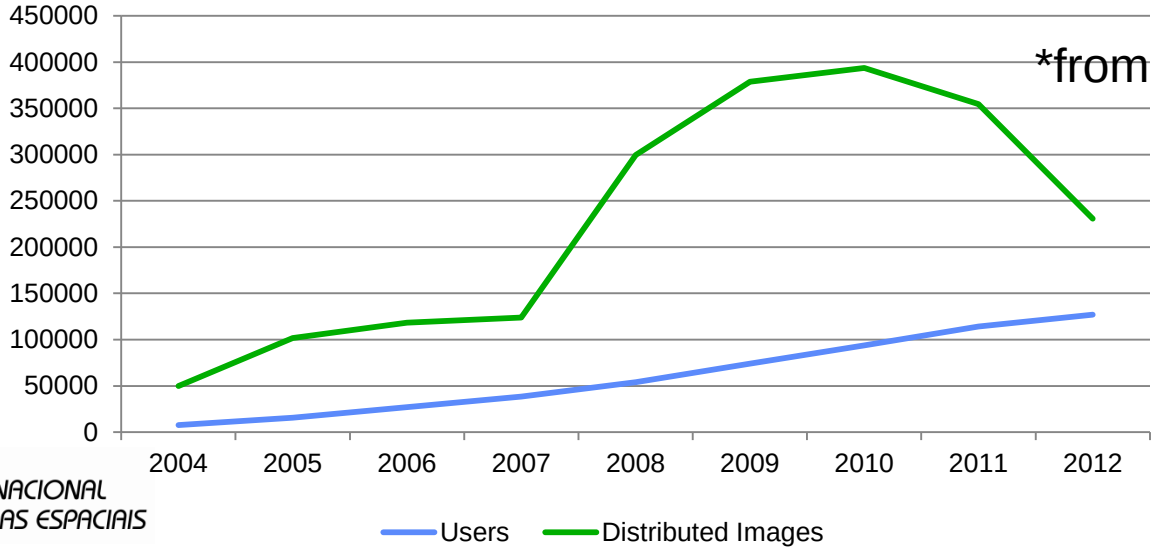
Data distribution under free data policy
(http://www.dgi.inpe.br/CDSR)

Satellite	2009	2010	2011	2012	Total*
CBERS (1,2,2B)	199,654	151,400	84,849	58,074	1,040,620
LANDSAT (1,2,3,5,7,GLS)	178,948	229,351	253,116	140,102	947,785
RESOURCESAT 1	0	12,849	14,887	30,892	58,628
AQUA	0	0	673	500	1,173
TERRA	0	0	1,160	989	2,149
Total	**378,602**	**393,600**	**354,685**	**230.557**	**2,050,355**



*from 2004 to 09/23/2012

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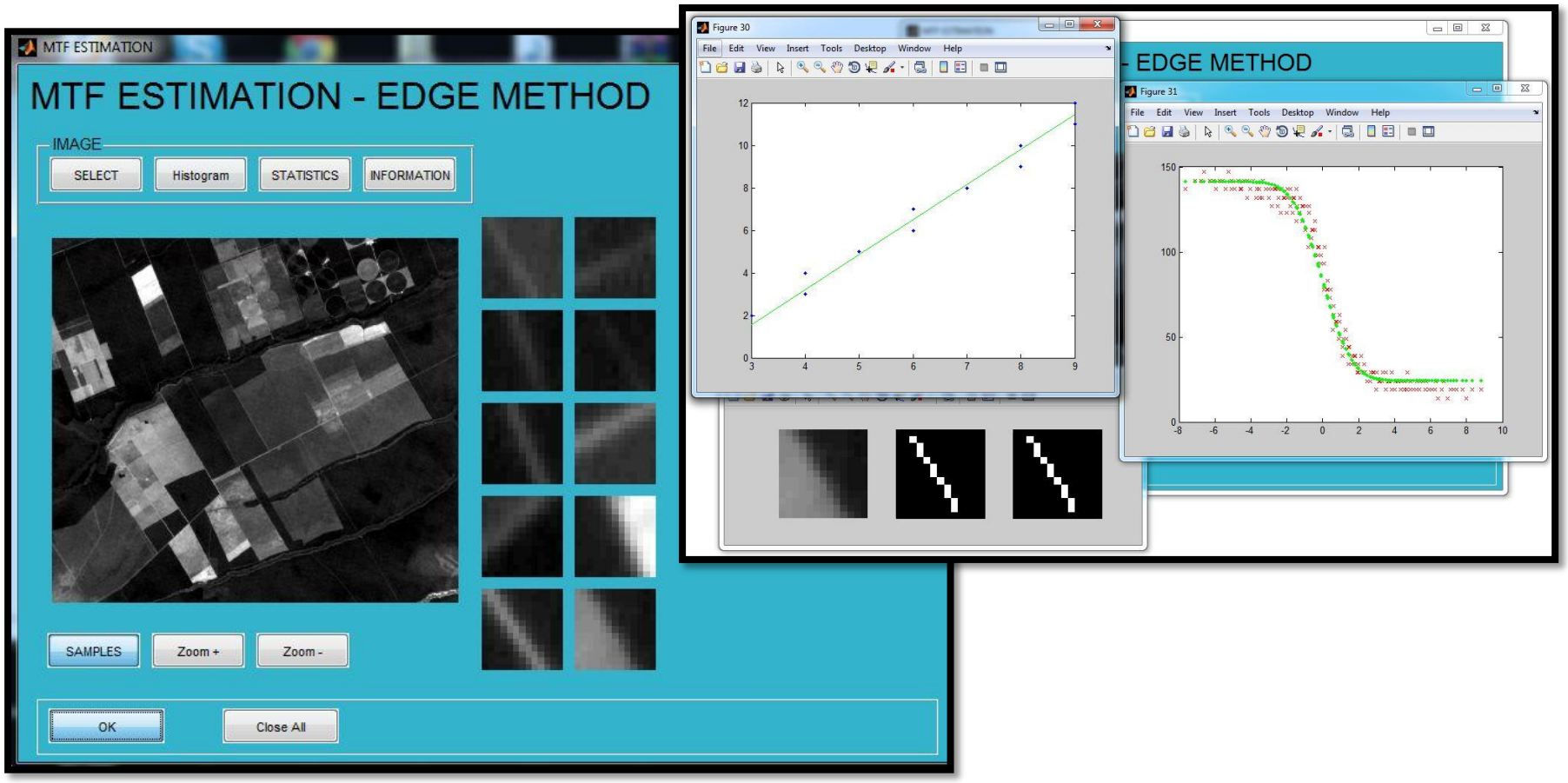
Ongoing activities on calibration/validation

Development of MTF evaluation method based on edge



Acknowledgment to CNPq (National Council for Research, Process 560253/2010-9) for providing financial support to develop this work

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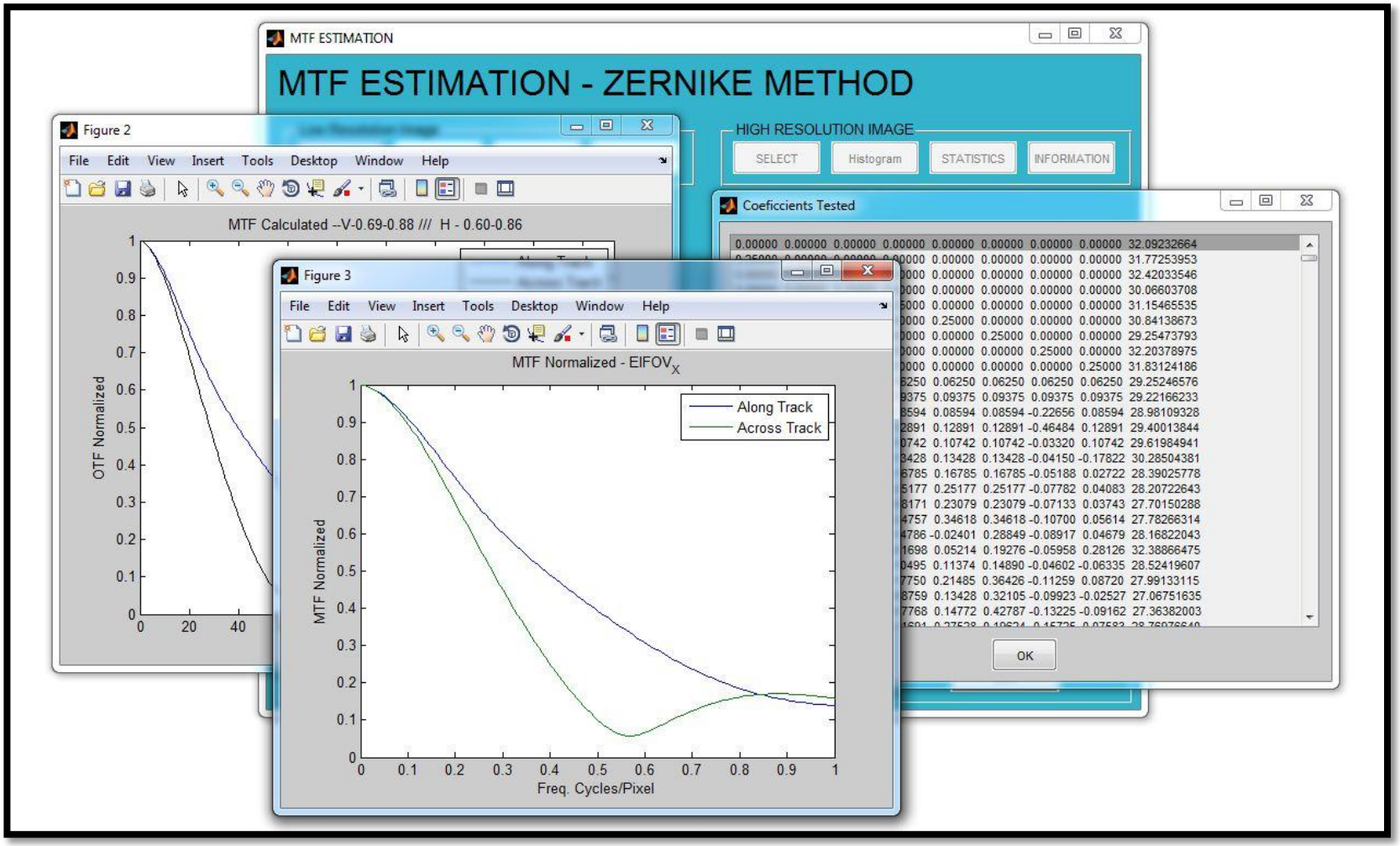
MTF evaluation: based on image simulation



Acknowledgment to CNPq (National Council for Research, Process 560253/2010-9) for providing financial support to develop this work

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Uncertainties assessment in orbital or airborne sensors absolute calibration

Cibele T. Pinto, Flávio J. Ponzoni, Giovanni A. Boggione, Leila M. G. Fonseca, Ruy M. de Castro

Proceedings of the 10th International Symposium on spatial accuracy assessment in natural resources and environmental sciences, Florianopolis, SC, 10-13 July, 2012.

This work aimed to evaluate the main uncertainties involved in the process of absolute calibration of optical sensors in the visible, near and middle infrared regions of the electromagnetic spectrum

Reference surface: Tuz Gölü (campaign, 2010)

Satellite: LANDSAT-5 (August, 18, 2010)

Acknowledgment to CNPq (National Council for Research, Process 560253/2010-9) for providing financial support to develop this work

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MUX camera (Brazil)

- Replaces CBERS 1/2/2B CCD camera (20 m)
- Improvements
    - Single CCD array for each band instead of 3 arrays for each band;
    - Internal calibration (LED based)
    - Focal plane position adjustment
    - Individual gain adjustment for each band
- Challenges
    - No beam splitter: difference of up to .5 s between acquisition times for different bands

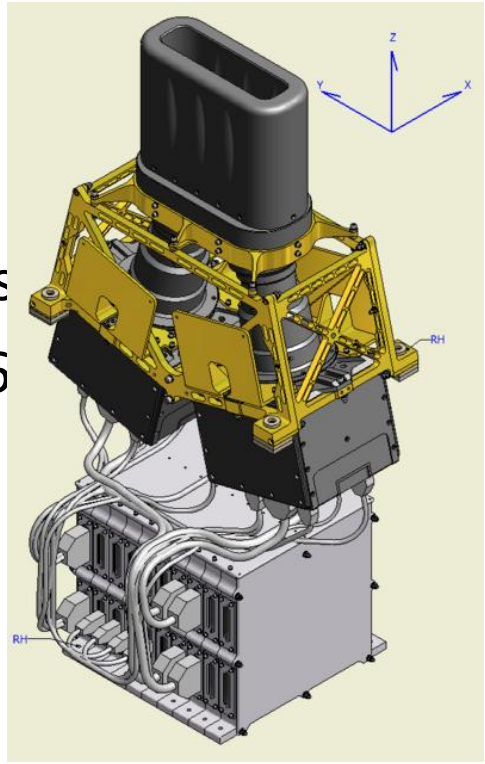
Backup slides

CBERS 3 and 4 sun synchronous orbit

Semi-major axis (average): 7148.8 Km
Inclination: 98.5 (o)
Eccentricity: 1.0x10-3
Argument of Perigee: 90 degrees
Local Time at descending node: 10:30 AM
Orbital period: 100.26 minutes
Repeat cycle: 26 days
Revolution/Day: 14 + 9/26
Distance inter ground track at equator: 107.4 km
Time interval between adjacent tracks: 3 days
Local time stability at descending node mean: +- 5 min.
Orbit traces stability at the equator: +- 5 km

WFI Camera (Brazil)

- Replaces WFI camera (CBERS 1/2/2B)
  - Two distinct optical systems
- Improvements
    - 10 bits quantization instead of 8 bits
    - Better resolution, 64m instead of 26
    - 4 spectral bands instead of 2
    - Internal calibration (LED based)
    - Individual gain adjustment
- Challenges
  - No beam splitter: difference of up to 1.9 s between acquisition times for different bands



IRS Camera (China)

- Replaces the IRS camera (CBERS 1/2)
- Improvements:
    - Better spatial resolution, 40m instead of 80m for IR bands and 80m instead of 160m for thermal)

PANMUX Camera (China)

- No similar camera in CBERS 1/2/2B
- Better resolution than CCD camera (20m) but no better than HRC camera (2.7 m) (CBERS-2B)

  3 Multispectral (10m resolution)

  Uses beam splitter to separate spectral bands

  1 Panchromatic band (5m resolution)
- Individual gain adjustment for each band
- Focal plane position adjustment
- Internal calibration