

Landsat Global Land Survey Initiative: An Update

**CEOS Working Group on
Calibration and Validation**

Ilhabela, Sao Paulo, Brazil, May 2009

Carlos Paz, Argentina, March 2005



Frascati, Italy, November 2005





Budapest, Hungary, May 2006

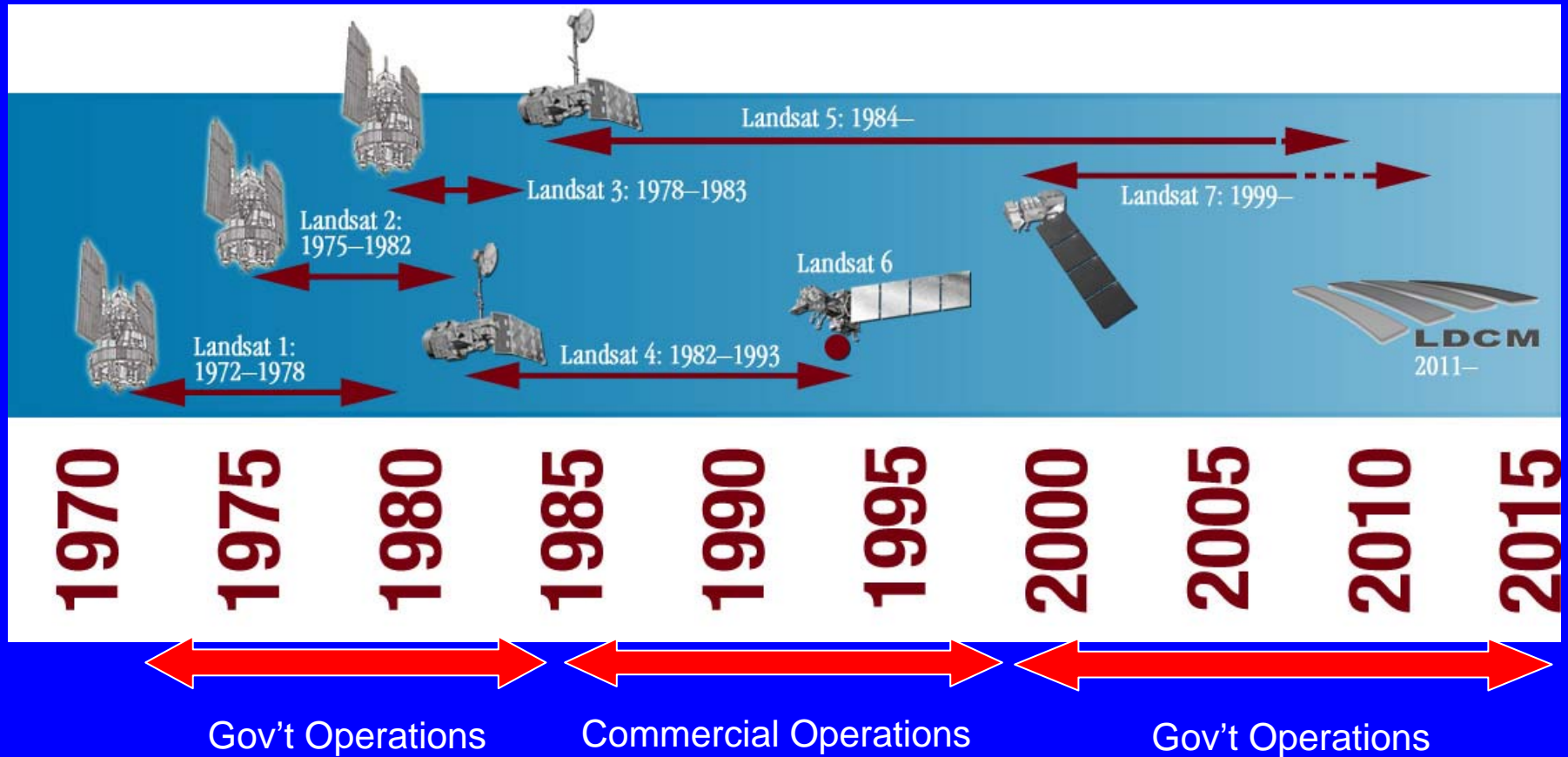
Chiang Mai, Thailand, October 2006



Avignon, France
October 2008



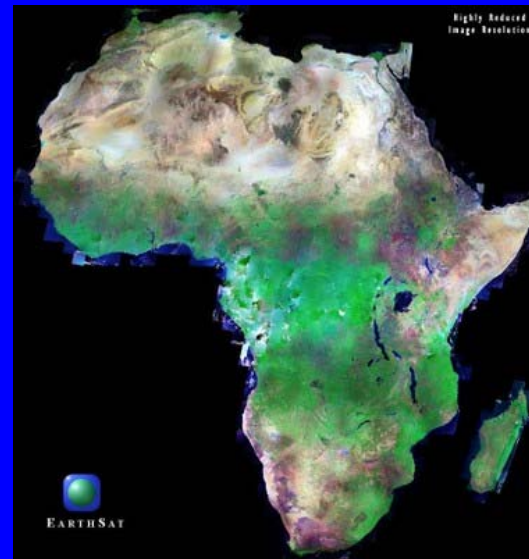
History of the Landsat Program



Global Land Survey Data Sets

Global cloud-free, orthorectified Landsat data sets centered on 1975, 1990, 2000, 2005, and 2010

- Partnership between USGS and NASA, in support of CCSP
- Support global assessments of land-cover, land-cover change, and ecosystem dynamics (disturbance, vegetation health, etc)
- Pilot project for routine global land-cover mapping in the next decade



GEOSS Task AG-06-04

- Task
 - Initiate an international assessment effort on forests and forest changes utilizing ongoing land-cover mapping projects (e.g. GLOBCOVER).
 - Ensure application of standardized classifications and harmonization of existing datasets
- Deliverables
 - Up-to-date user needs assessment for forest/land cover observations for forestry at regional and global scales
 - Launch and progress for GEOSS implementation project on international forest assessments
 - Availability and adoption of land characterization standards and updated land cover data.

GLS History: Milestones

- 1997: NASA contracts with Earthsat Corp (later MDA Federal) to produce a wall-to-wall Landsat coverage for 1990 and 1975 [Geocover product]
- 2001: NASA contracts for a Year 2000 follow-on dataset
- 2006-2008: NASA and USGS partner to
 - Reprocess earlier Geocover datasets with MDA - new dataset called “Global Land Survey (GLS)”
 - Create new GLS-2005 data set for 2004-2007 period
- Pave the way for the GLS-2010

GLS 1975-2005

Existing Geocover 1975, 1990, and 2000 data sets have been reprocessed to improve geometry (“GLS” standard)

- SRTM digital topography (+ DTED, CDED, NED)
- improved density of ground control
- <25m RMSE_r error for 2000; <40m for 1990; <75m for 1975

GLS-2000, -1990 now complete and available for download via GLOVIS/EarthExplorer and bulk order

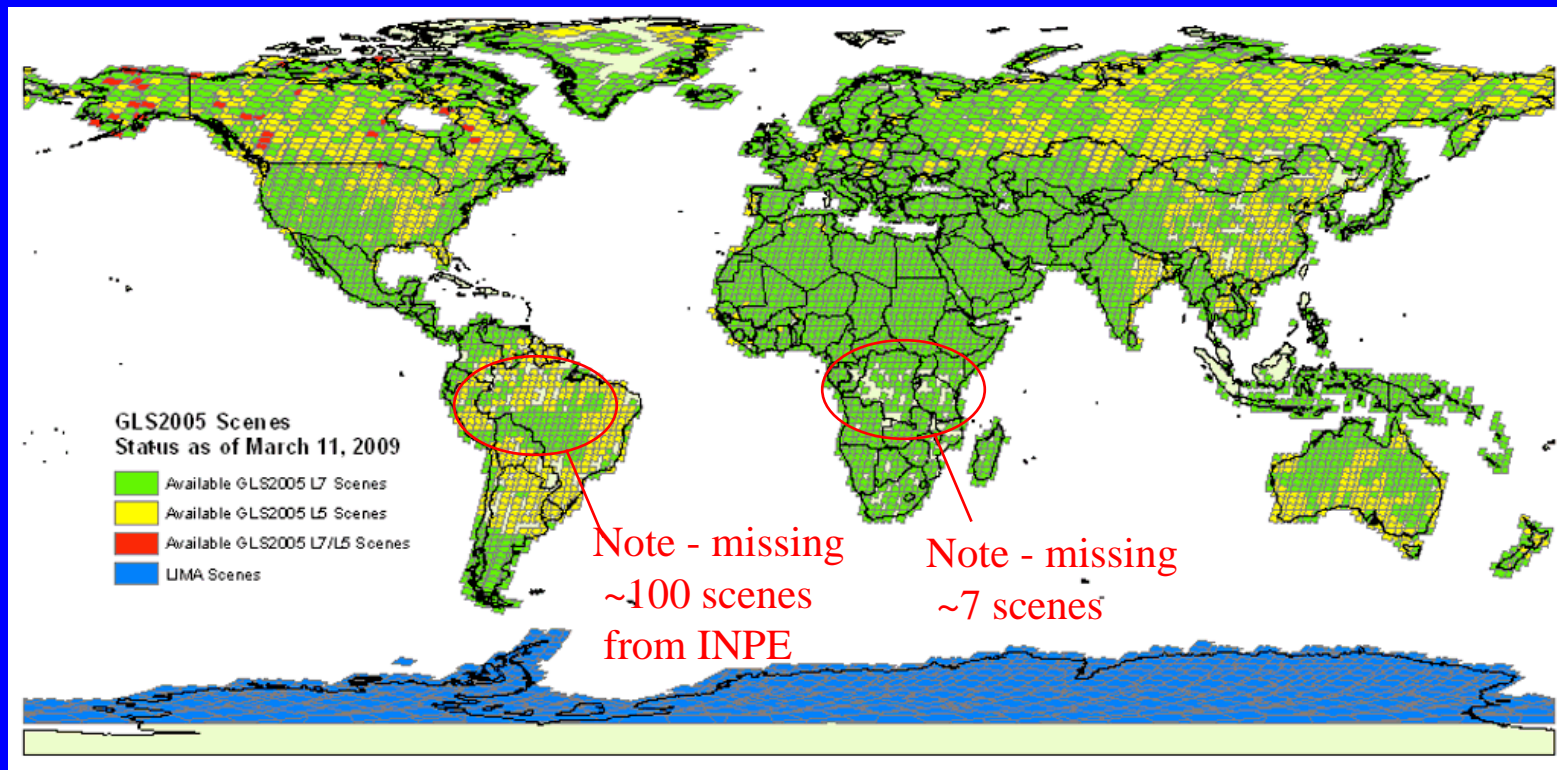
GLS-2005 98% complete, available for download

- few scenes to be reselected for QA, missing scenes in Africa
- EO-1 ALI island/reefs scenes being processed

GLS-1975 released in mid-April

GLS-2005 Current Status

- Until completion, GLS-2005 available on per-scene basis through GLOVIS/Earth Explorer
- Bulk data distributed to International Cooperators and LCLUC ROSES 2007 GLS team members to enable 2-year analysis schedules



GLS-2010 Overview

- Need for GLS-2010
 - Pre-sorted “best of archive” for land-cover science
 - Inclusion of International Data
 - Gap-filled products from Landsat-7
 - Decadal consistency for change detection
- 2009-2010 acquisition window
- USGS/NASA MOU Signed 2008
- Relying on Landsat-5 and -7, but with international contributions through CEOS Land Surface Imaging (LSI) Constellation

GLS2010 Schedule & Plans

2009

- Set up L5 campaign stations, begin downlinks
- Target EO-1 ALI acquisitions for islands and reefs
- Obtain sample data sets from SPOT-5, CBERS-2b, AVNIR, THEOS

2010

- Continue ground station operations
- Additional international data acquisition/contribution?
- Begin scene selection process via LASSI
- Deploy gap-filling code at GSFC

2011

- Obtain collects from IC's
- Process L5/L7 data to L1T at EROS
- Gap-filling of L7 imagery at GSFC
- Release final product by end of 2011

International Participation

- Letter sent to space agencies in October 2008 soliciting data contributions through CEOS LSI Constellation activities
 - Regional Data Set Initiatives (Townshend)
 - GLS-2010 (Masek)
- Positive responses from JAXA, CNES, INPE, CONAE, GISTDA
- Initially focused on three “target” areas for data intercomparison (Central South America, southern Africa, SE Asia).
- Spring 2009: Work with agencies to acquire data and host through CEOS Land Portal.

Science Products

The GLS effort is focusing on both data products and long-term land-cover analysis

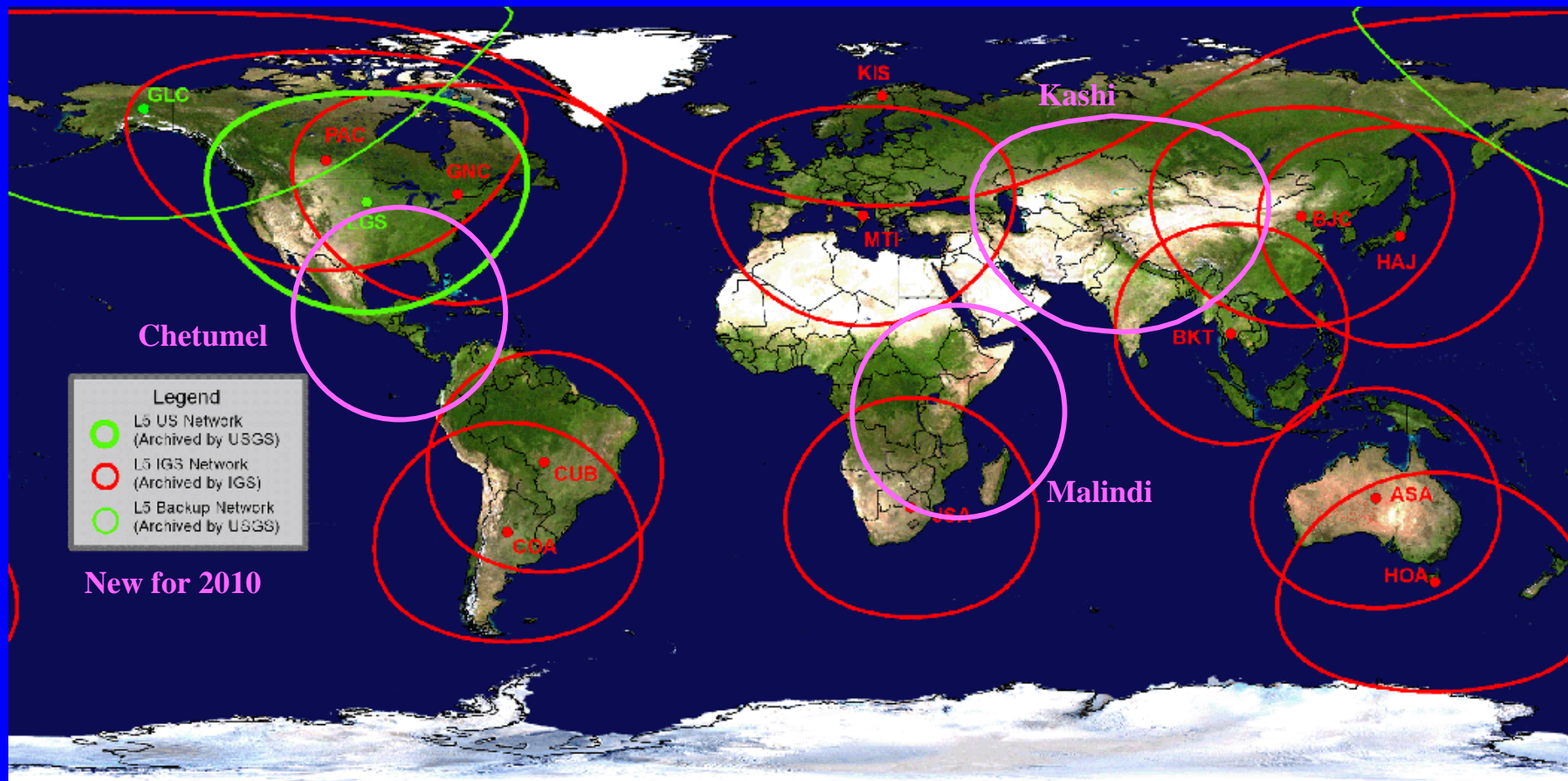
NASA LCLUC (ROSES2007) and Earth Science Information Systems programs are funding analyses of GLS (1975-2005) record:

- **Chander, G. (USGS EROS) - Sensor cross-calibration**
- **Davis, B. (NASA SSC) - Sensor intercomparison for land cover**
- **Giri, C. (USGS EROS) – Monitoring Tropical Mangrove Forests**
- **Hansen, M. (SDSU) – Forest Cover in Humid Tropics**
- **Skole, D. (MSU) – Tropical Forest Cover Change**
- **Townshend, J. (UMD) –Global Forest Cover Change Data Record**
- **Xiao, X. (UNH) – Land Cover Products for Monsoon Asia**

Issues

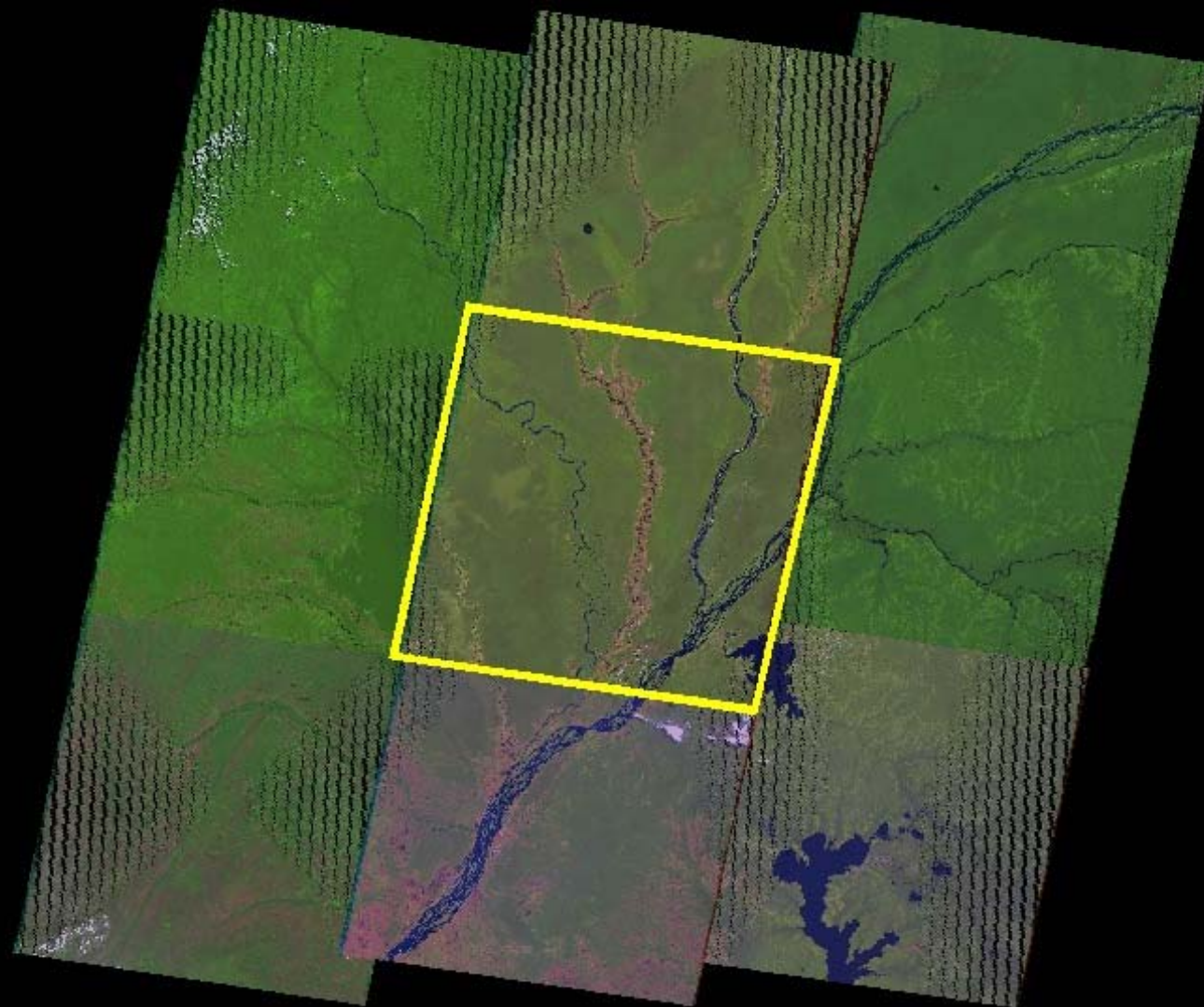
- Data policy and redistribution
- Levels of data processing and product specifications
- Gap-filling of ETM+ SLC-off data
- Data archive and distribution – centralized or distributed?
- Instrument cross-calibration and generation of multi-instrument products

Landsat-5 Ground Stations



Coverage Summary

- Landsat-7 can acquire global coverage (but with SLC gaps)
- Between CBERS and AWIFS, only west Africa, central America, southern South America, and Greenland cannot be acquired
- Adding Landsat-5 IGS and Campaign stations, only west Africa cannot be acquired
 - Chetumal campaign station critical
 - Russian campaign stations critical in the absence of AWIFS
 - Malindi station critical in the absence of CBERS and/or₁₉ failure of CBERS to implement Africa network

**Downloadable**

WRS-2
Path / Row: 81 60 Go
Lat/
Long: 0.0 17.3 Go

**Scene Information:**

ID: LE71810602006175ASN00
Date: 2006/6/24

Jun 2006 Go

Prev Scene

Next Scene

GLS 2005 Scene List

Add

Del...

Down...



1000m No Limits Set

Remaining Issues

- A number of systems exist or are planned but there is NO Coordination
- There is no agreed upon global acquisition strategy by the space agencies or move in that direction
- Data availability from the alternate international satellites (CBERS, AWIFS) for large areas is non existent
- Data policies are inequitable
- LDCM and Sentinel 2 are a ways off
 - there is no Landsat 9 planned
- The LSI Constellation is getting poor support
- The international aspects of GLS 2010 are moving very slowly

Conclusions

- Global Land Surveys offer decadal views of the Landsat archive for monitoring land-cover trends
- GLS-1975, -1990, -2000 reprocessed
- GLS-2005 is available now; complete by mid-2009
- Development of GLS2010 is underway

“Satellites for Public Good” (INPE)

- Perhaps, globally coordinated for a more efficient use?
- Landsat data have become free, CBERS too. Shouldn't others follow the suit?
- Perhaps, we could join our efforts in coordination of the future sensors and launches. And, then...

Post Scriptum: Garik's Dreaming



- Imagine all the CEOS getting its act together
- All Landsat-like systems are developed in coordination
- All future launches are scheduled in concert
- There are a dozen satellites in space so that each target on earth is revisited daily
- What would it take?

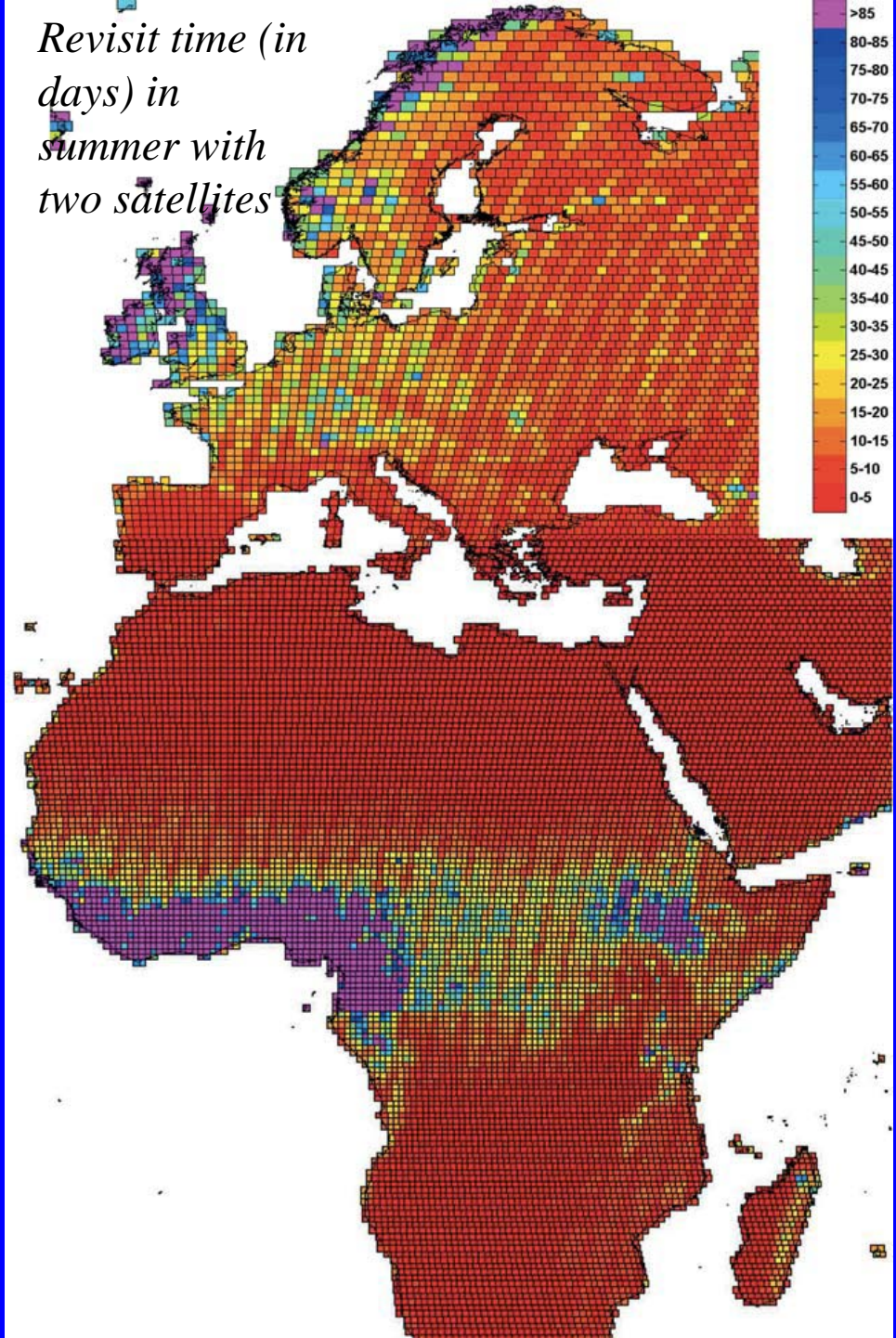
The Sentinel-2 mission is dedicated to the full and systematic coverage of land surfaces (including major islands) from 56°S (southern Americas) to +83°N (northern Greenland), providing cloud-free products every 15–30 days. To achieve this and for reliability, a constellation of two operational satellites is required, yielding **5 days** between revisits. At the beginning, with only one satellite, the gap is 10 days (although optical instruments on other GMES satellites will help to fill the gaps).

In order to support operational services for at least 15 years from the launch of the first satellites, a series of four satellites is planned, with two operating in orbit and a third in ground storage as backup

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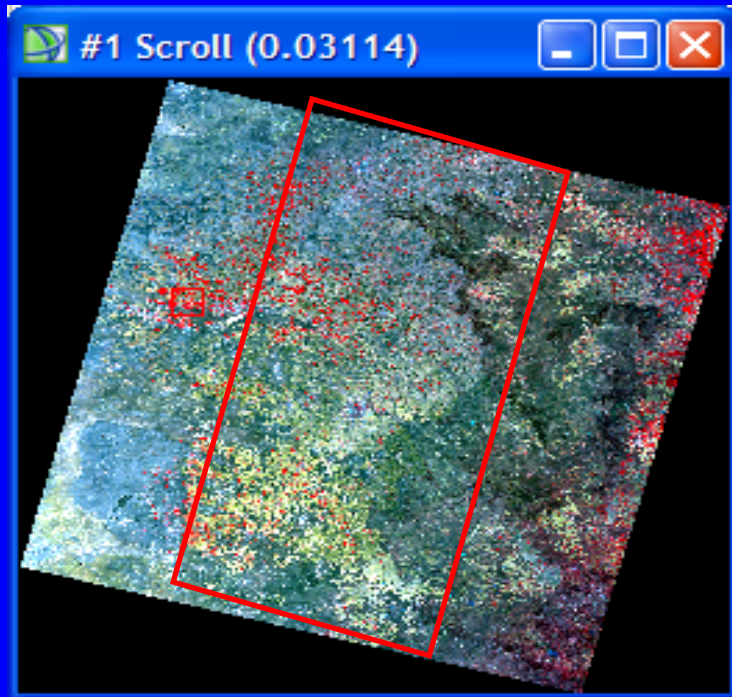
Revisit time (in days) in summer with two satellites



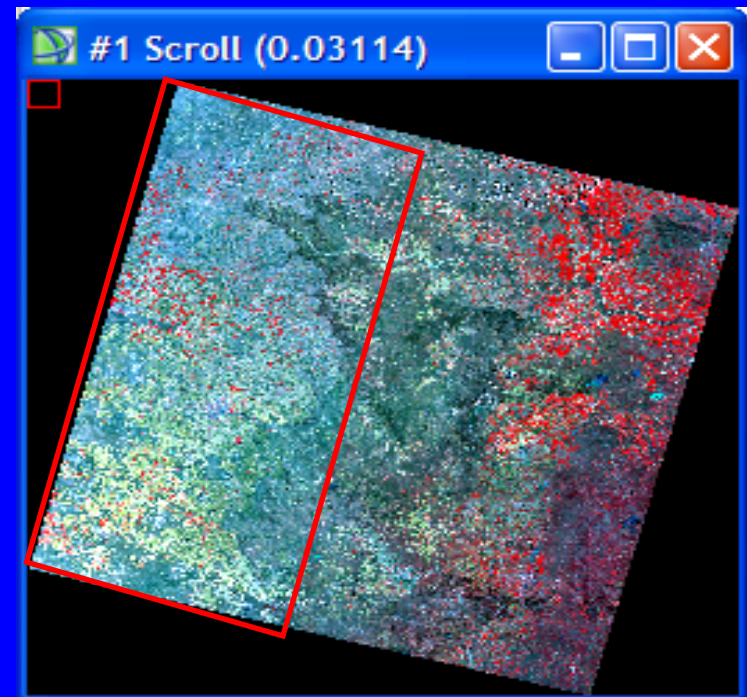
How to Achieve Almost Daily Coverage with 10-30m Spatial Resolution by 2015?

- 2 Sentinels
- 2 Landsats with wider swath (about double of the present)
- Additionally
 - 1-2 CBERS modified
- All sensors intercalibrated
- Launched in a staggered fashion
- Common protocols developed
- Readout capability uniform
- Data policy resolved ²⁷

US Midwest AWiFS Scenes



4/13/08, 264/45/D

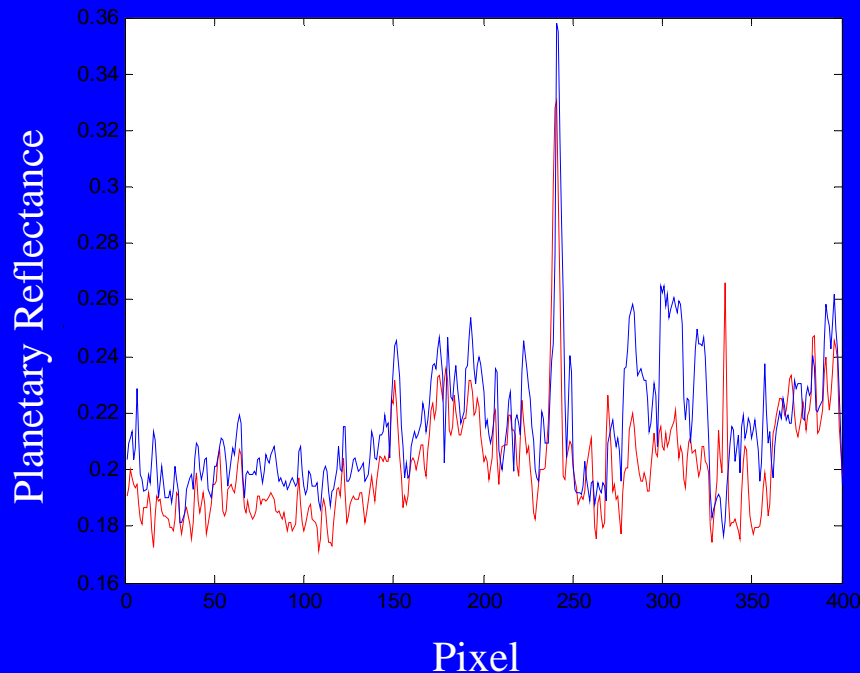


4/18/08, 265/45/D

28 Overlapping cloud free area highlighted

Early Observations

- Random horizontal profiles taken across a corresponding region of two adjacent scenes
 - Scenes acquired 4/13 and 4/18 (very similar solar azimuth and elevation)
 - NIR band
- Approximately .02 difference in reflectance due to viewing geometry differences



Sample
Profile
Pair

- You may say I am a dreamer
But I am not the only one,
I hope some day you'll join us
And the world will be as one

Terra

Aura

