

Landsat 5 & 7 Mission Status & Mid-Decadal Global Land Survey

briefing to the

Land Cover and Land Use Change
Science Team Meeting

presented by

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October 10, 2006



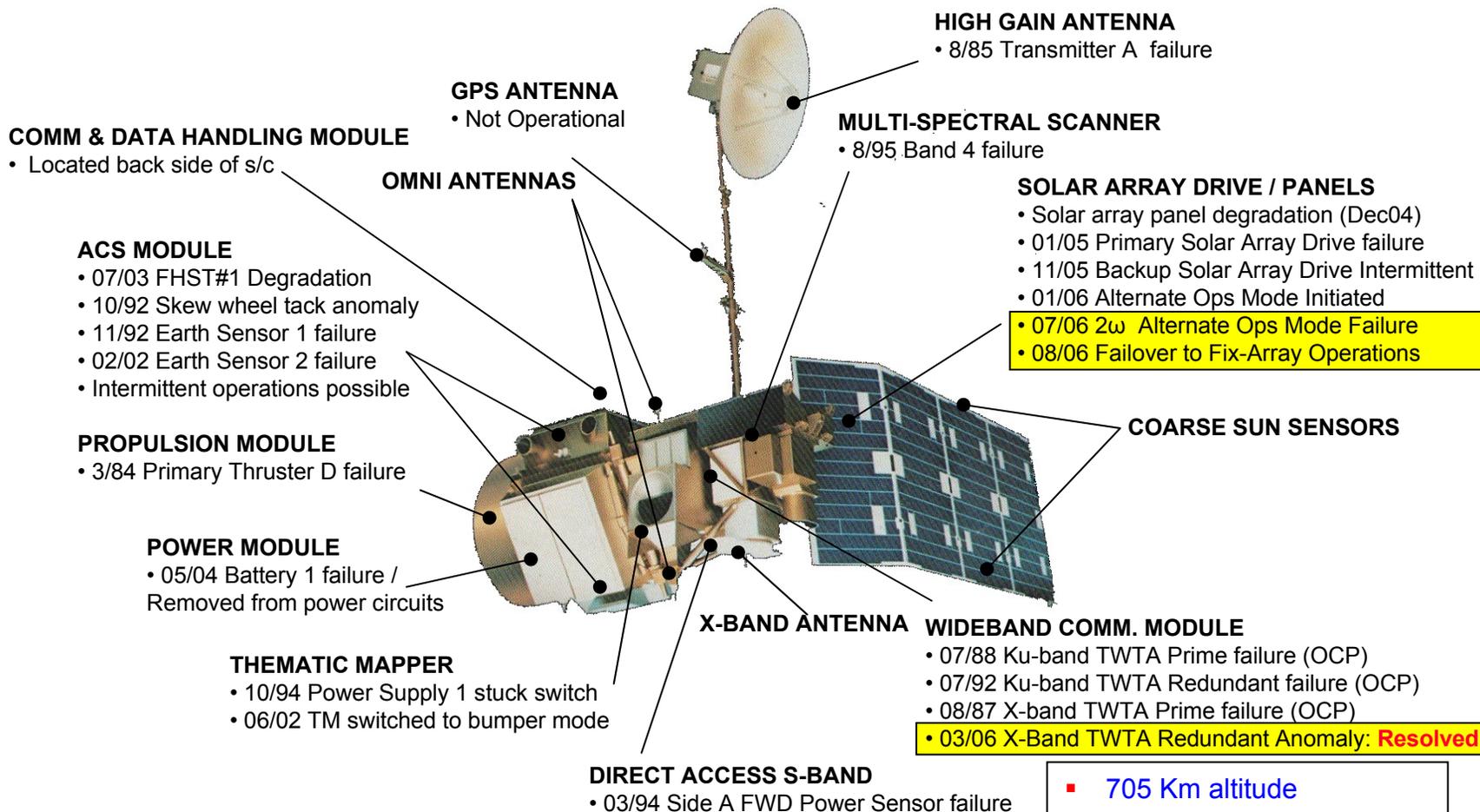
Agenda

- **Landsat 5 Mission Status**
- **Landsat 7 Mission Status**
- **Highlights of the Mid-Decadal Global Land Survey**

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Landsat 5 Status Overview

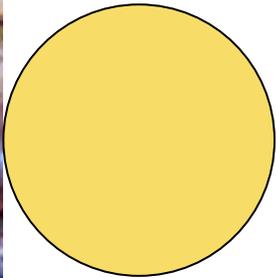


- 705 Km altitude
- Circular/Polar Orbit
- Launched March 1, 1984

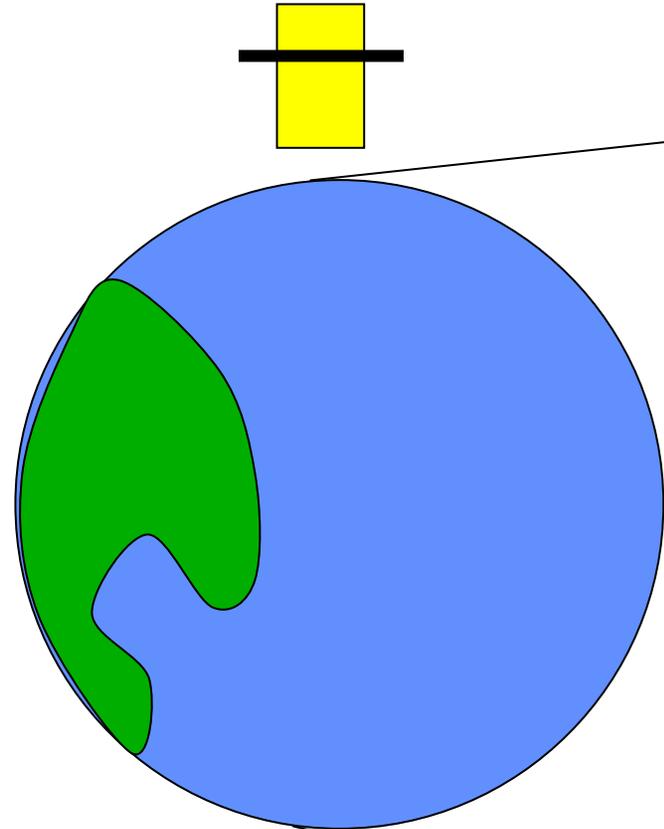


Fixed-Array Concept of Operations

Static Pitching

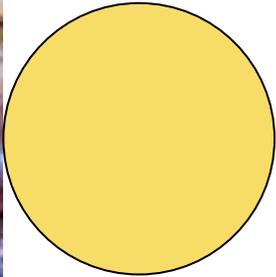


The nadir-pointing spacecraft has limited power collection and a longer 'night'

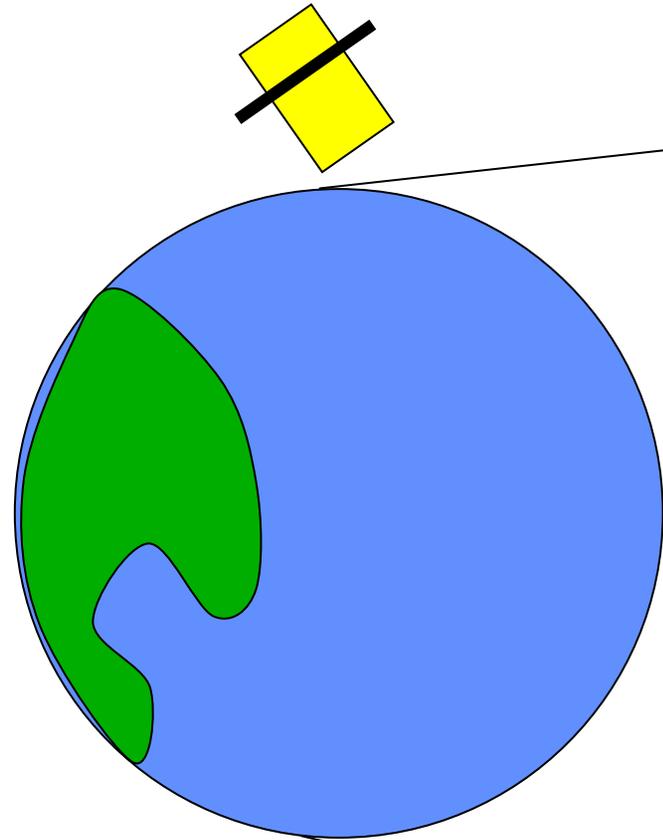


Fixed-Array Concept of Operations

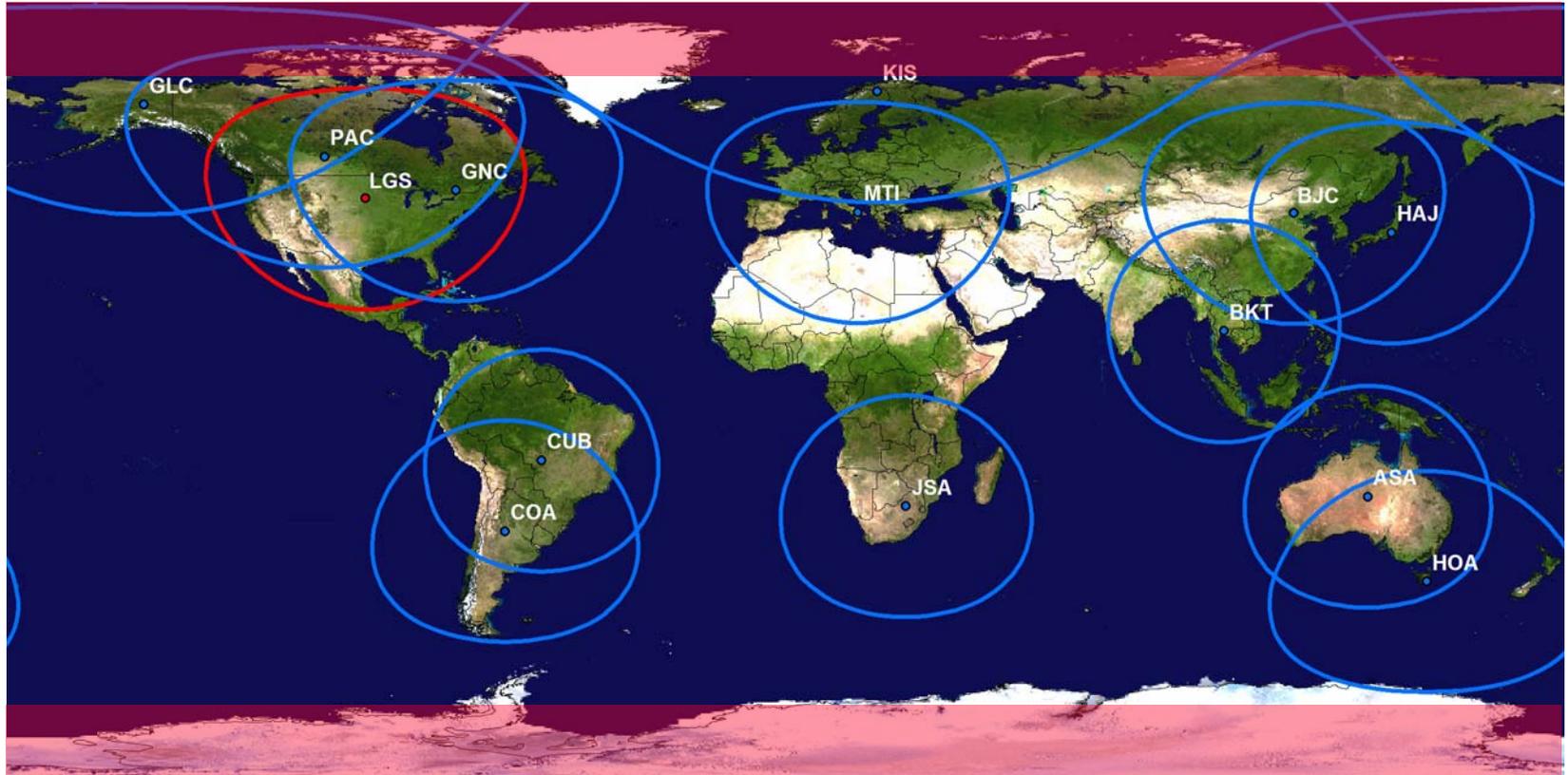
Active Pitching



With a pitching spacecraft, the solar array can collect more power, allowing more imaging operations

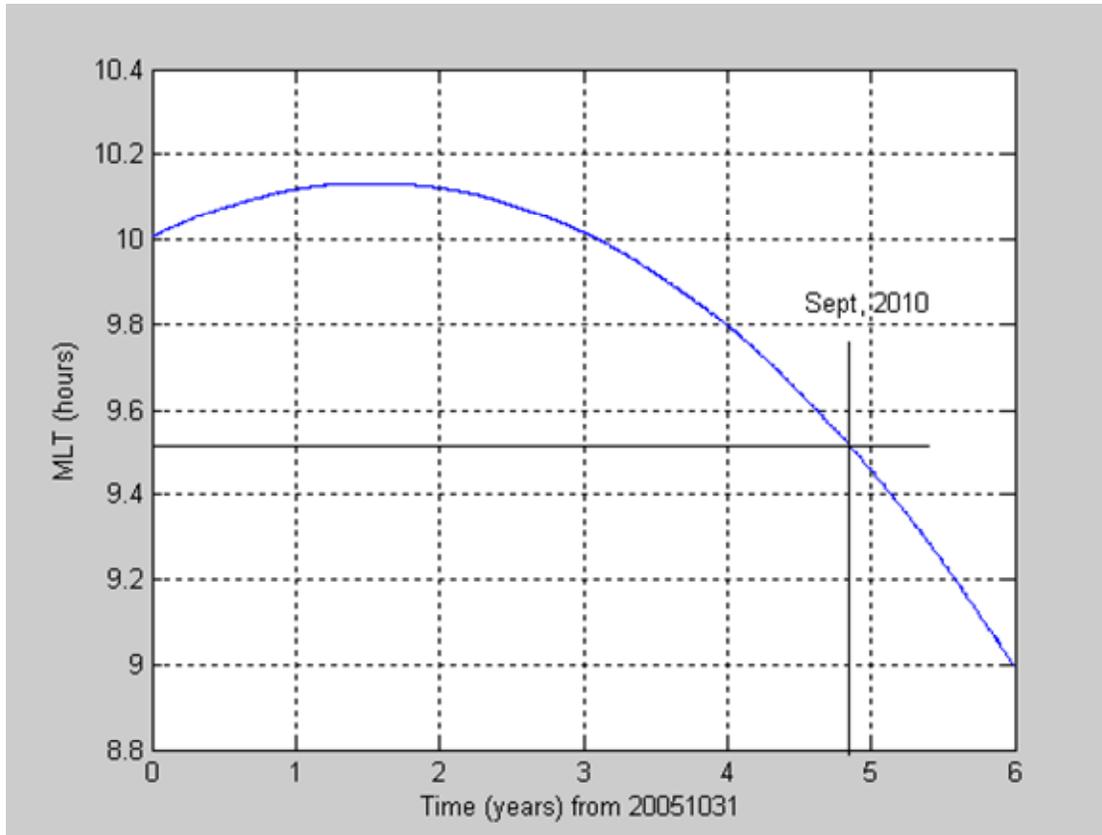


Landsat-5 IC Network Coverage



Operational imaging cannot be supported in the polar regions

Landsat 5 End of Life Prediction



Mission specification:
Equatorial crossing
time must be greater
than 9:30 MLT

Without mechanical failures, Landsat 5 is expected to deplete its fuel reserves around September, 2010.

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Landsat 7 Spacecraft Status

ETM+

- 5/31/2003 SLC Failure
- 05/07 Likely end of SAM Mode

Instrument Aperture

Full Aperture Calibrator

Cooler Door (Open)

Attitude Control System

- 05/05/2004 Gyro 3 Shut Off

Gimbaled X-band Antennas
(04/26/2000 GXA/ETM+ Interaction discovered)

Earth Sensor Assembly

Solar Array

- 5/14/2002 EPS Circuit #14 Failure
- 5/16/2005 EPS Circuit #1 Failure
- (Each circuit represents 1/16 of capability, 12/16 needed)

Solid State Recorder

- 11/15/1999 SSR PWA #23 Loss
- 02/11/2001 SSR PWA #12 Loss
- 12/07/2005 SSR PWA #2 Loss
- (Each PWA is a 4% loss of capacity and is likely recoverable)

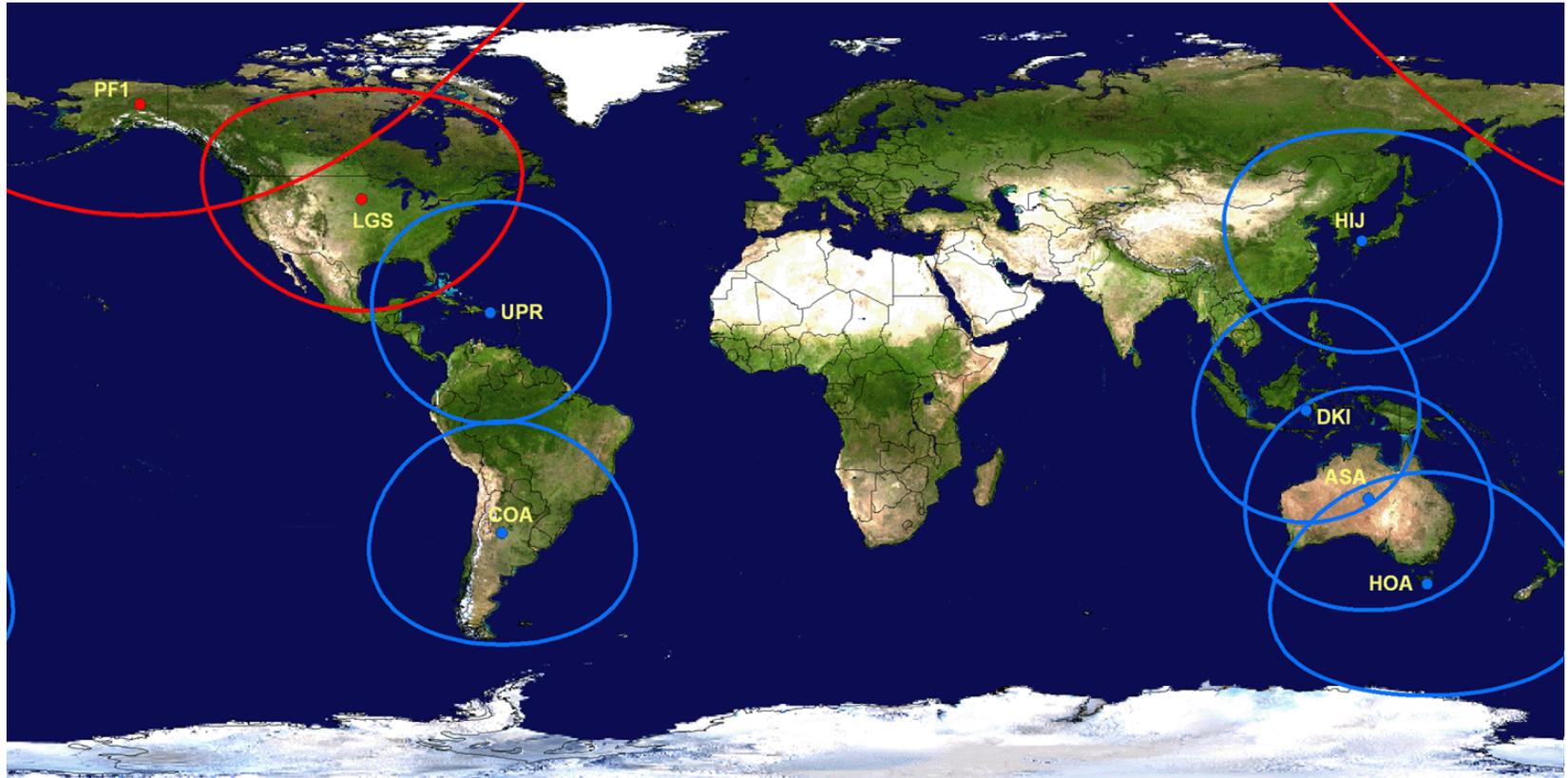
Reaction Control System

- 1/7/04 Fuel line #4 thermostat #1a failure.
- 2/24/05 Fuel line #4 thermostat #2a failure

S-band Omni (1 of 2)

- 705 Km altitude
- Circular/Polar Orbit
- Launched April 15, 1999

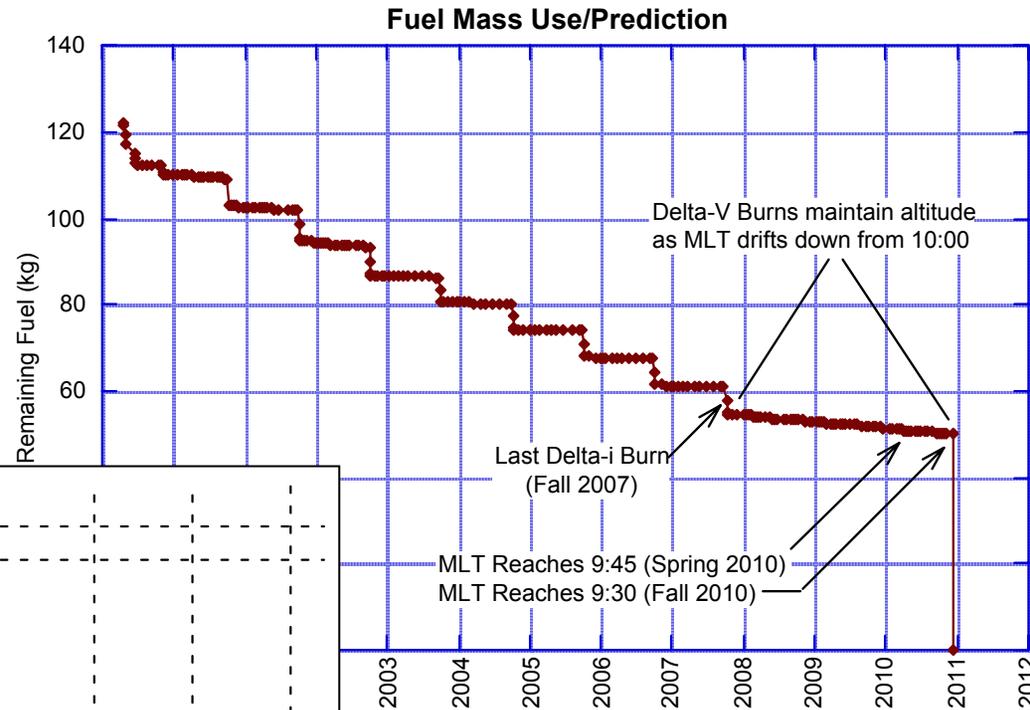
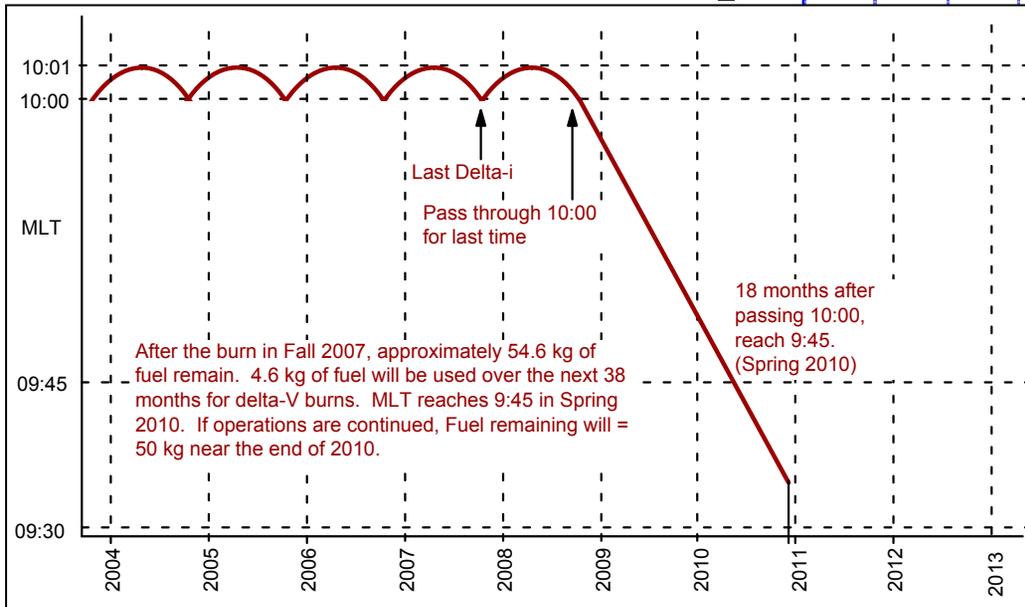
Landsat 7 Ground Network



Landsat 7 End of Life Prediction

- **Fuel Usage Study Results**

- ◆ FOT devised method to predict fuel mass in future years, taking into account non-linearity of temp/mass/thrust.



- ◆ An study is now underway to evaluate potential strategies for extending mission life beyond December 2010

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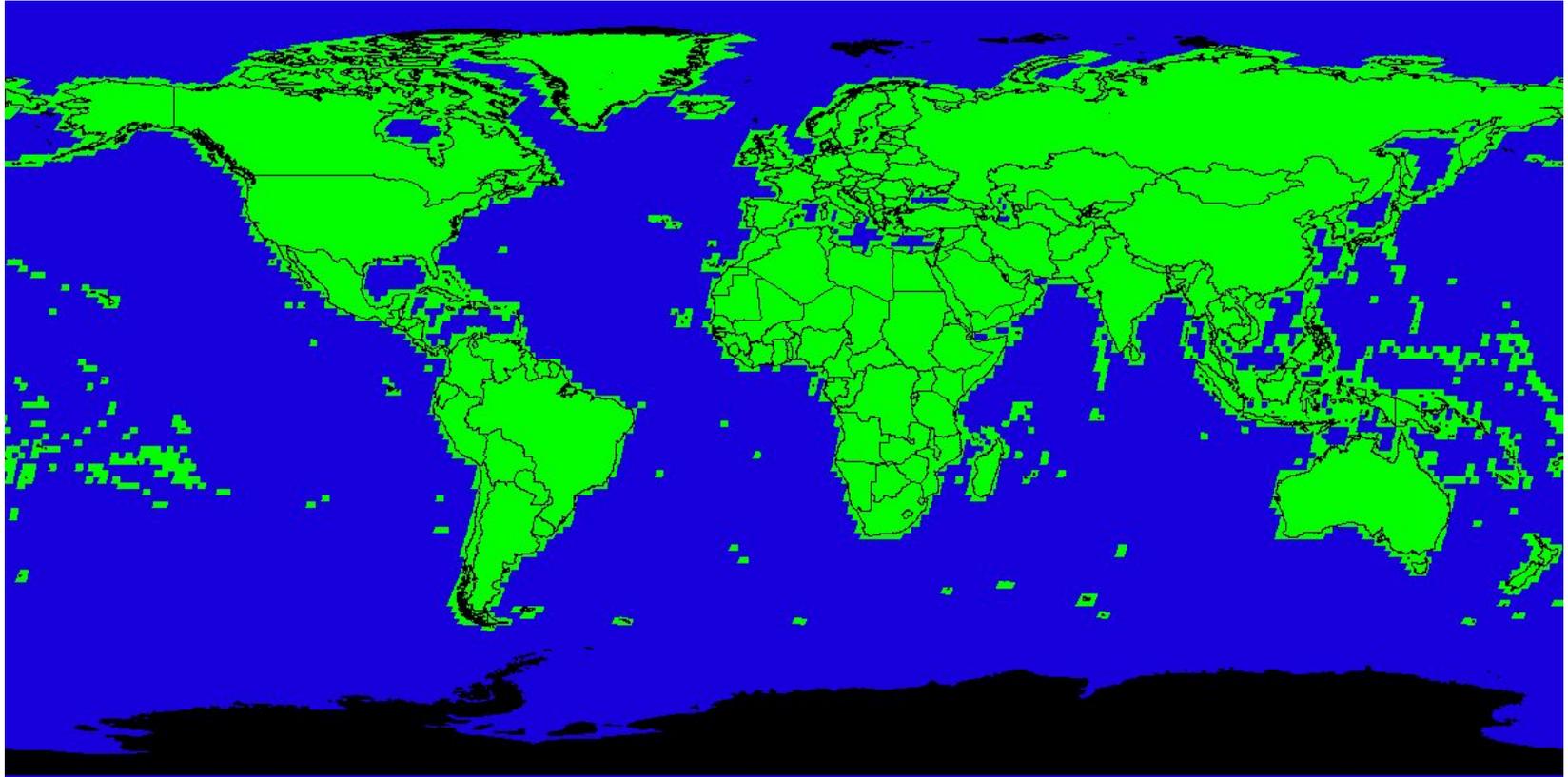
Mid-Decadal Global Land Survey

- **Mid-Decadal Global Land Survey – MDGLS**
- **The USGS and NASA have worked together in the past to create three global surveys of the Earth’s landmass from orthographically-corrected satellite imagery centered on specific timeframes**
 - ◆ 1970’s, 1990 and 2000
- **The objective of the Mid-Decadal Global Land Survey (MDGLS) is to extend this series with a new global land survey centered on a 2005-2006 epoch**
- **The Project has 2 Phases:**
 - ◆ Phase 1: satellite tasking, ground station coordination, scene selection, data transfer, and ingest into the USGS archive
 - Landsat 5 TM as primary data source
 - Landsat 7 ETM+ as the secondary source
 - Other sensors: ALI, ASTER, AWIFS, ...
 - ◆ Phase 2: Process the collected data into an ortho-rectified dataset compatible with previous surveys

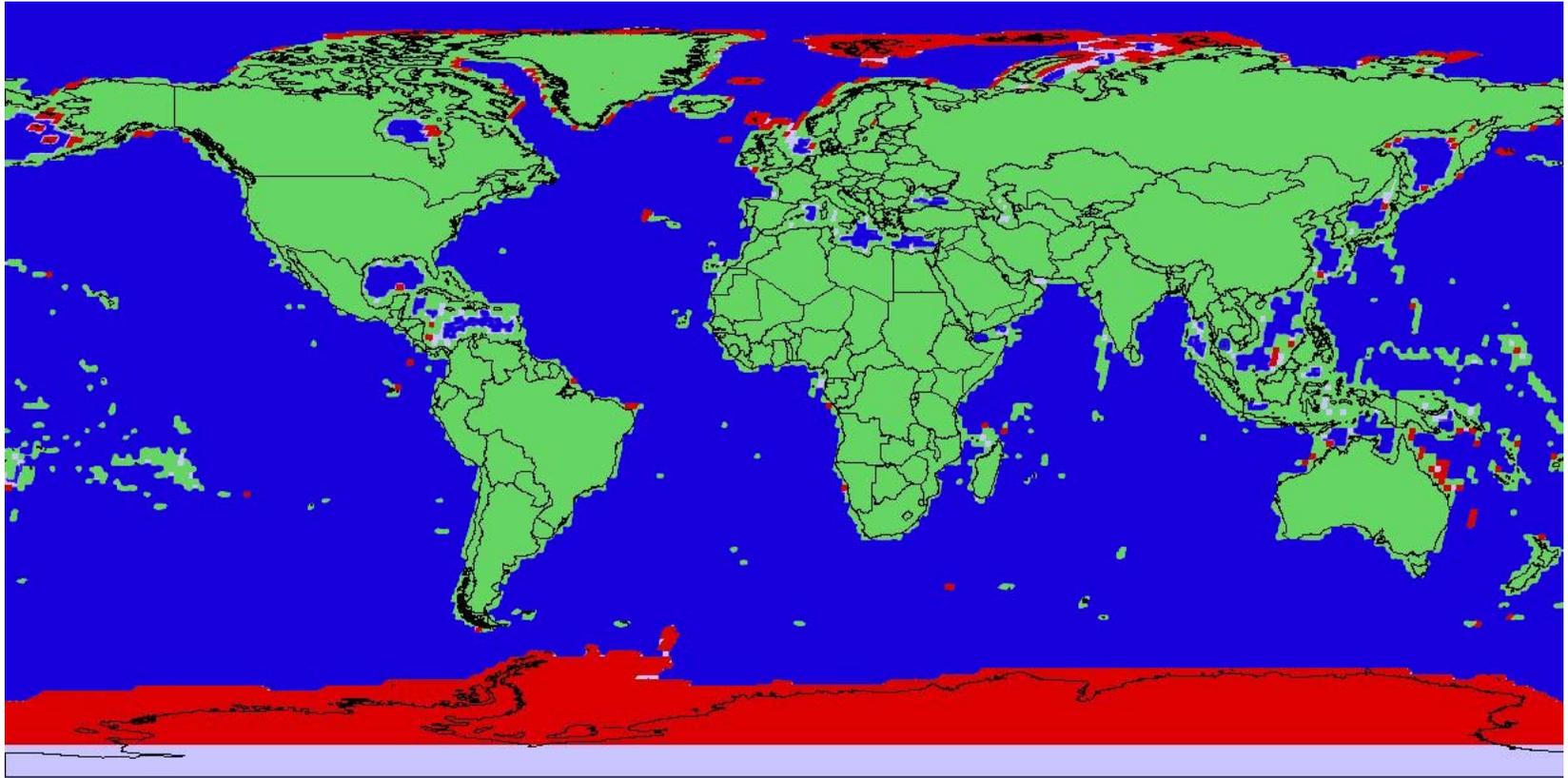
Mid-Decadal Global Land Survey

- **Past Surveys' Coverage of Unique Coverage**
 - ◆ 1970's: 6,976 path/rows
 - ◆ 1990: 7,037 path/rows
 - ◆ 2000: 8,209 path/rows
- **MDGLS will increase total coverage to around 9,500 scenes**
 - ◆ Better accounting of islands and reefs
 - ◆ Inclusion of the Antarctic continent
 - ◆ Full coverage of Arctic area in 'ascending' orbit
- **The MDGLS Scene Baseline includes 13,106 unique path/rows**
 - ◆ This number includes Antarctica, but doesn't exclude the geographic coverage overlap at high latitudes
 - ◆ Antarctica accounts for 3589 Path/Rows (~1200 unique coverage)
 - ◆ The final MDGLS unique scene count should be in the range of **9500** path/rows

GeoCover 2000 Coverage



MDGLS Baseline Coverage

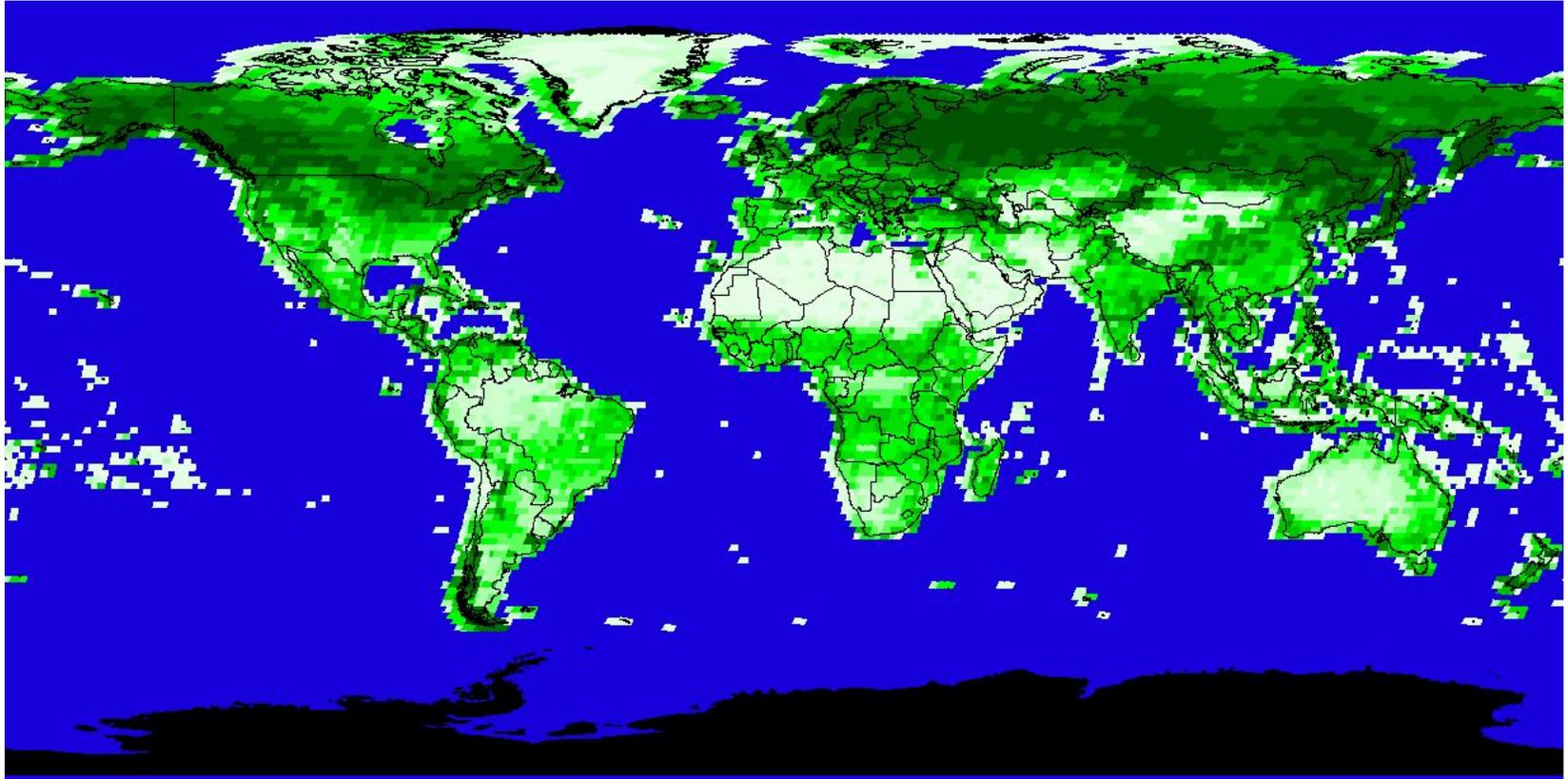


Green = GeoCover 2000 Coverage
Red = New MDGLS Coverage

Scene Selection Criteria

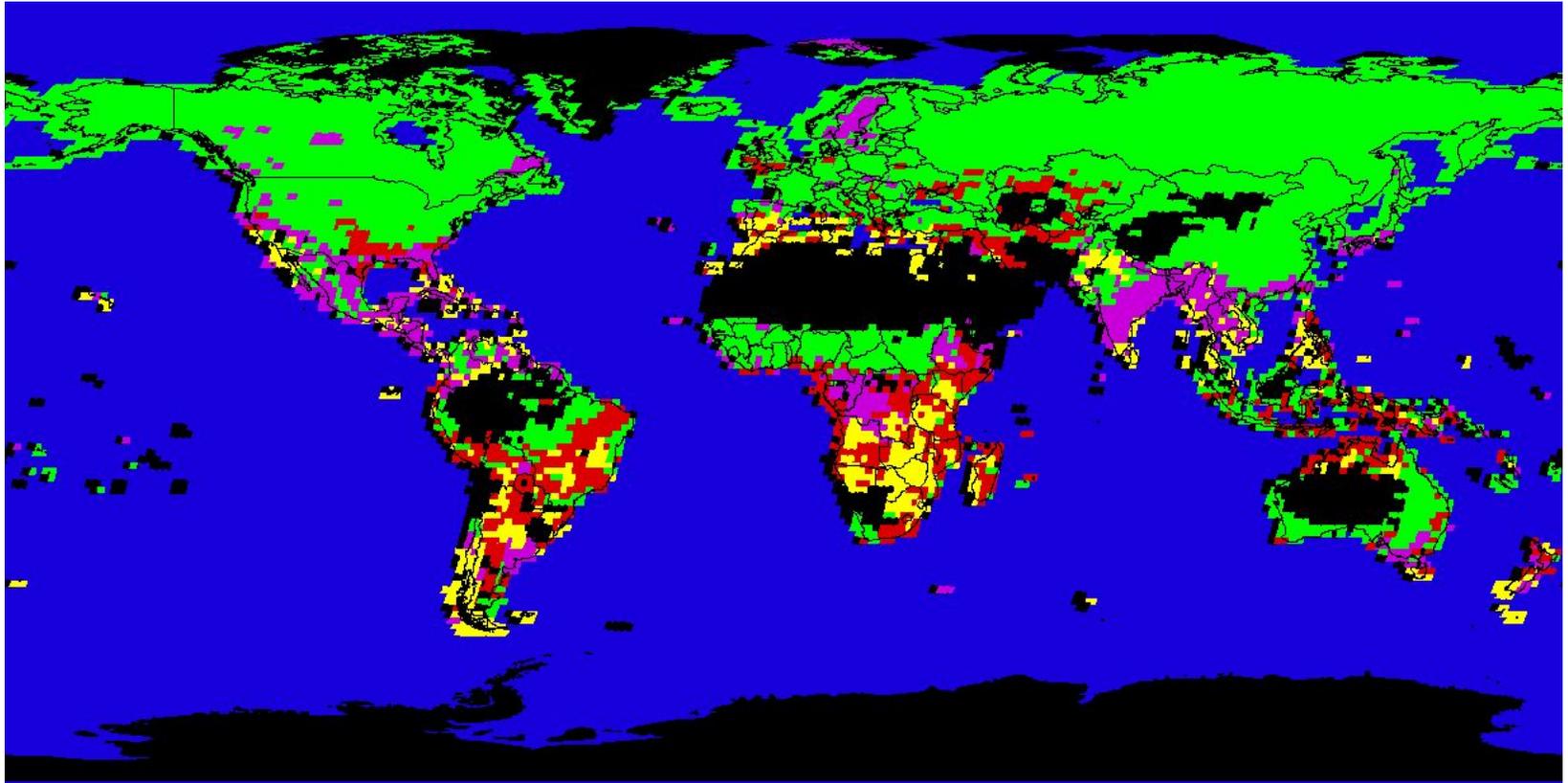
- **Mid-decadal acquisition period of 2004-2007**
 - ◆ (2005-2006: Prime)
- **Cloud Cover $\leq 10\%$**
- **ETM+ Composite Pair filler allowed up to 20%**
 - ◆ Landsat 7 Gap Closure of $> 95\%$
 - Assumes the allowance of a 2-pixel interpolation
- **Coverage Seasonality**
 - ◆ NASA's Jeff Masek provided NDVI maps to illustrate the actual dynamics of the ground cover
 - ◆ Based on these maps, USGS generated scene-specific date specifications:
 - Quiescent areas: Areas with an NDVI that doesn't move more than ± 0.2 over a year's period
 - Green Season: For all other areas, a date criteria was developed that matched the period when the NDVI was within 40% of its maximum value and dynamic range

NDVI Composite Dynamic Range



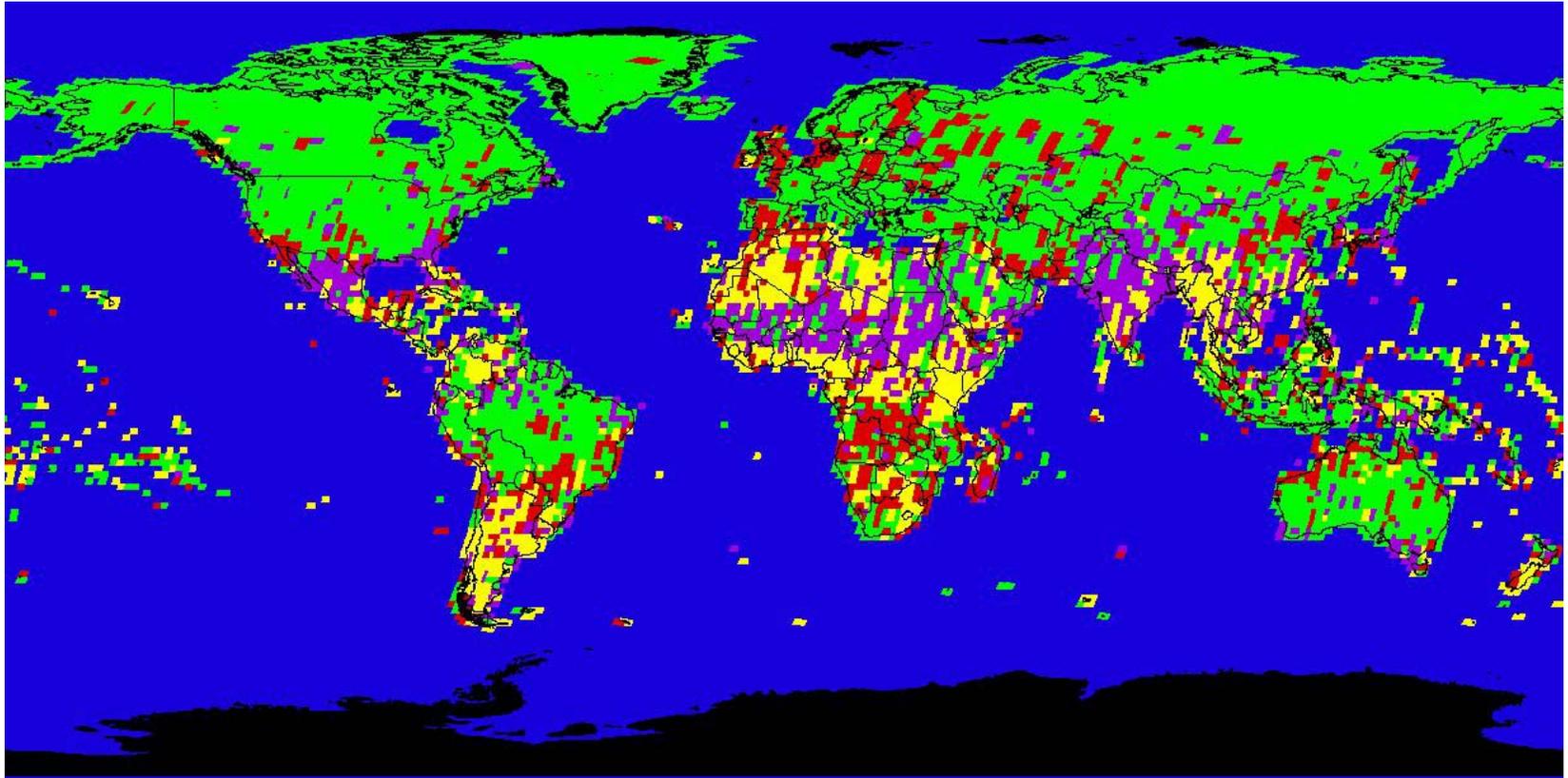
Green: Darker color – More Dynamic

New Survey Date Criteria Map



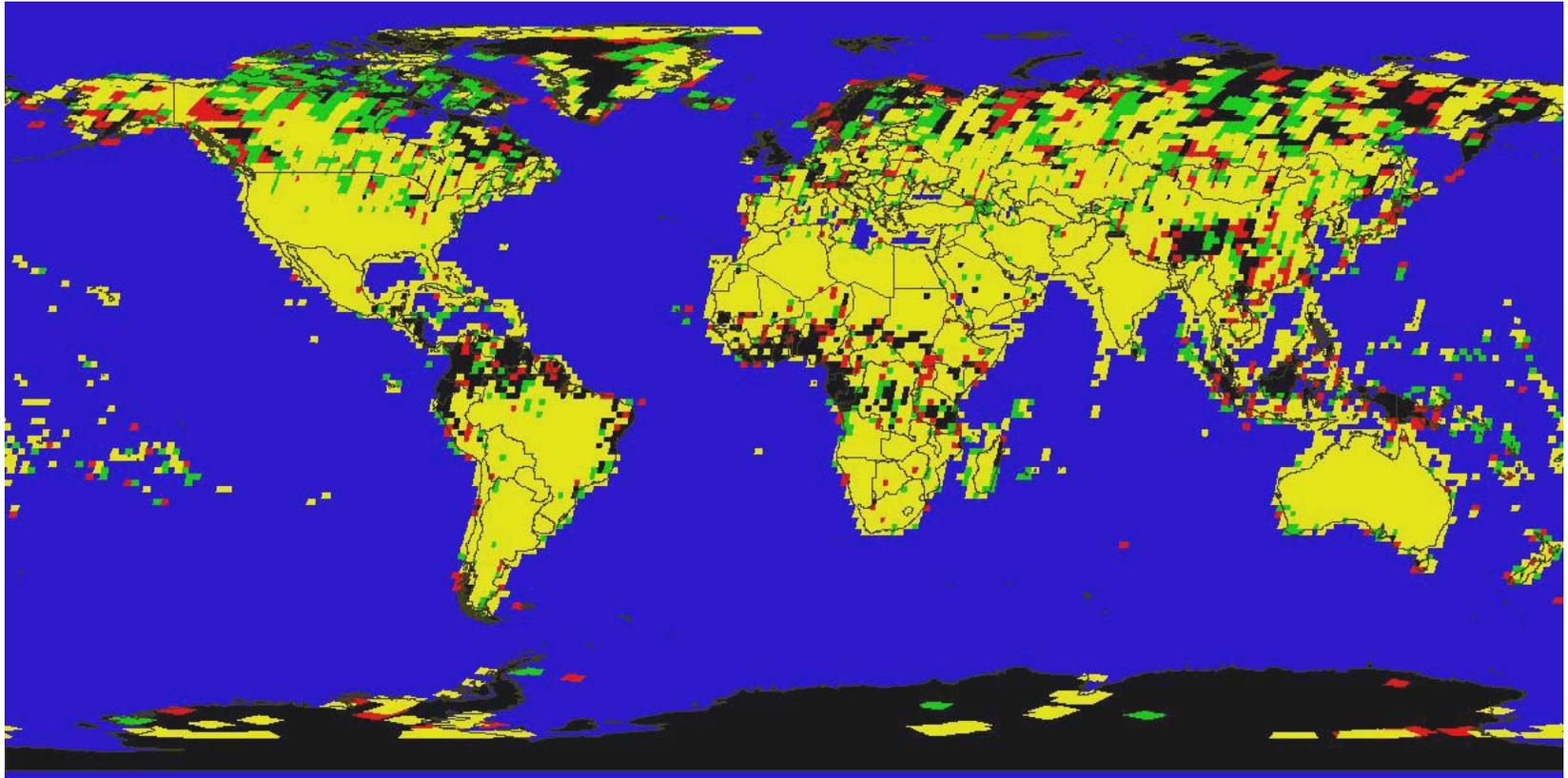
- Green** = NH Summer (Jun, Jul, Aug, Sep)
- Red** = NH Spring (Apr, May)
- Violet** = NH Fall (Oct, Nov)
- Yellow** = NH Winter (Jan, Feb, Mar, Dec)

GeoCover 2000 Seasonality



- Green** = NH Summer (Jun, Jul, Aug, Sep)
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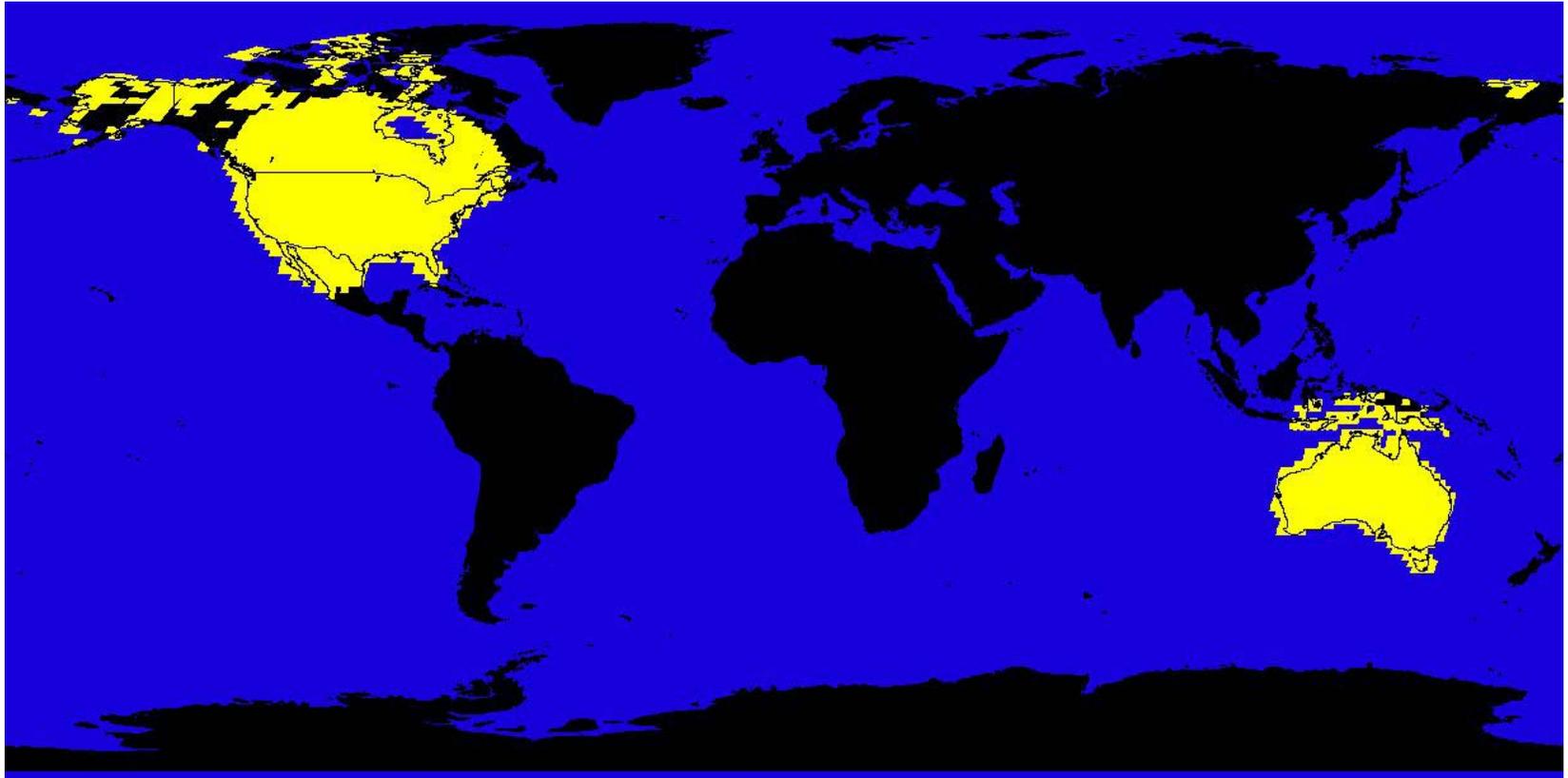
Archived L7 Coverage Meeting Specification



Yellow = 2005 Coverage
Green = 2006 Coverage
Red = 2004 Coverage

- ~90% of the P/R locations Covered
- $\bar{\Delta}$ in Composite Pairs: 1.24 Cycles

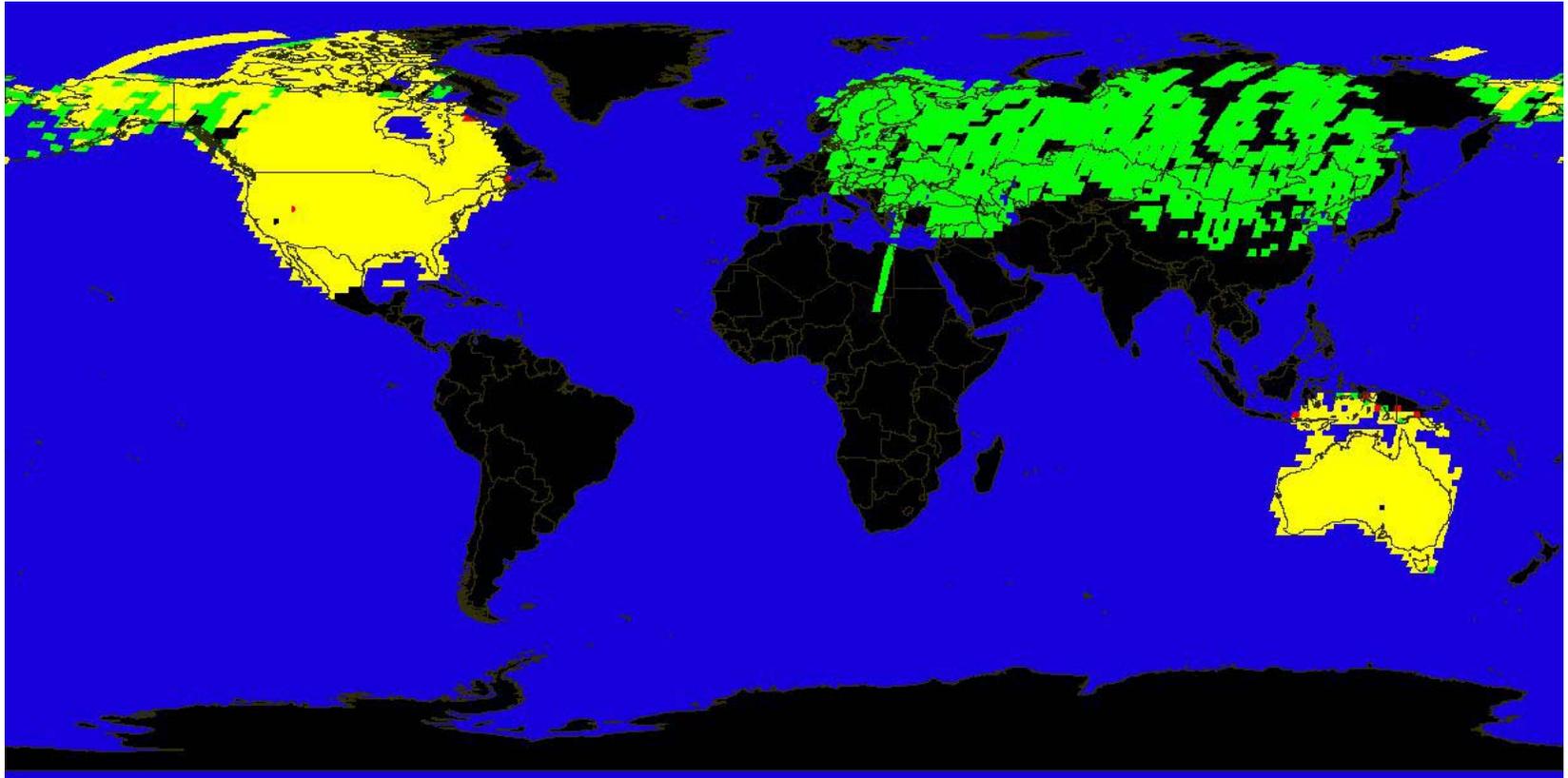
Archived L5 Coverage Meeting Specification in April



Yellow = L5 Coverage

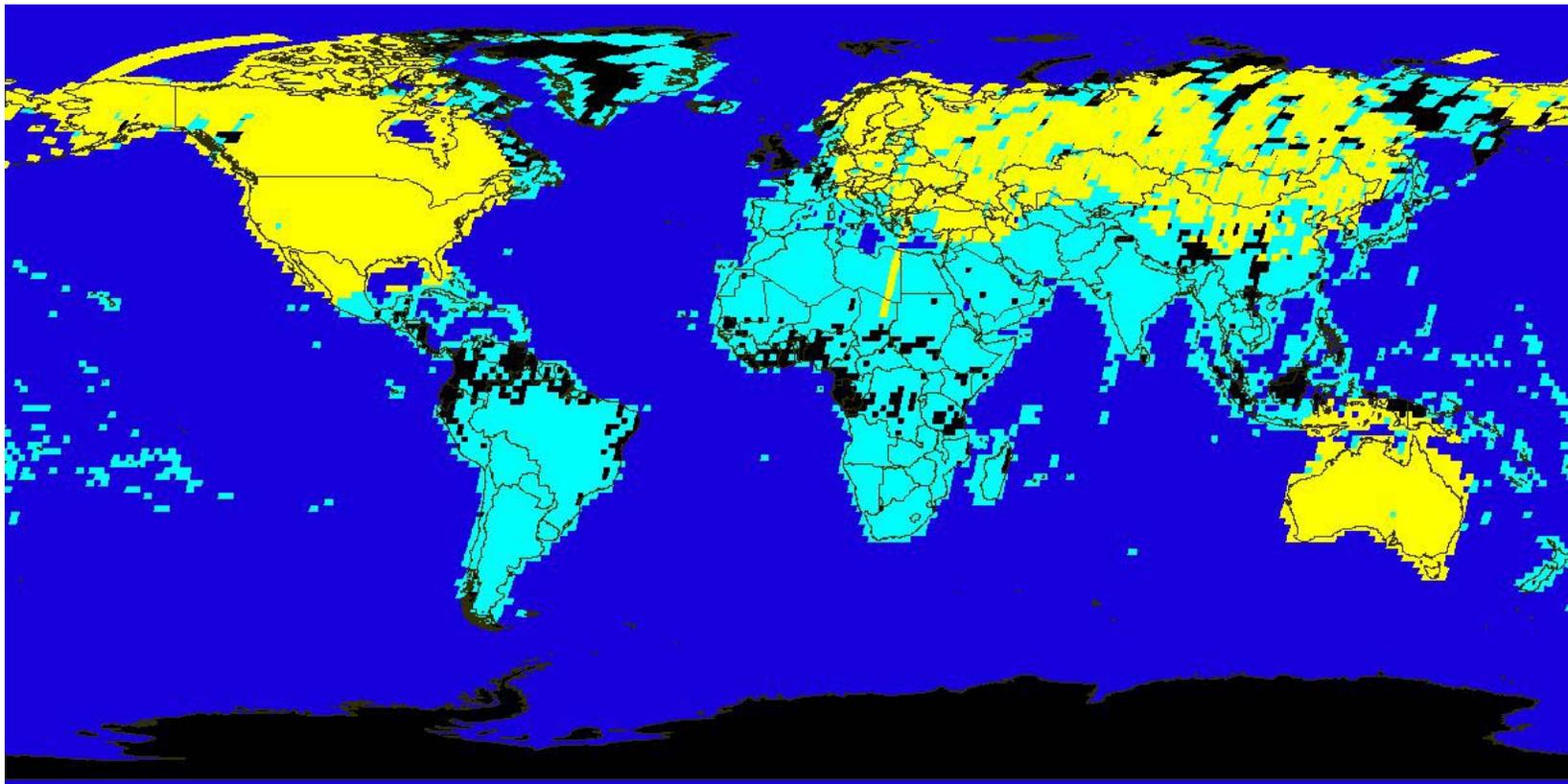
21% of the P/R locations Completed

Archived L5 Coverage Meeting Specification Now (excluding Kiruna)



Yellow = 2005 Coverage
Green = 2006 Coverage
Red = 2004 Coverage

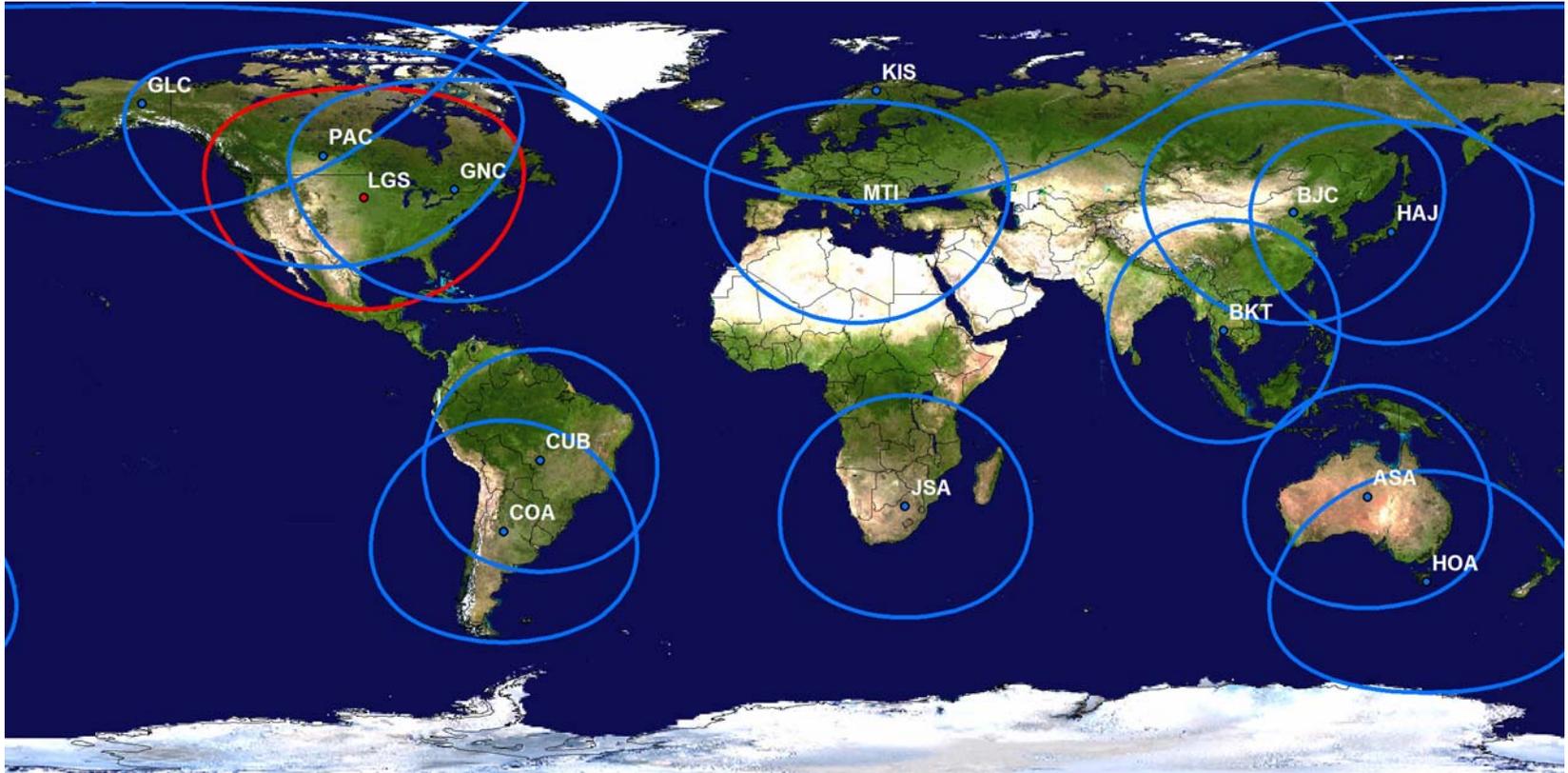
Combined Archived Coverage in EROS Archive



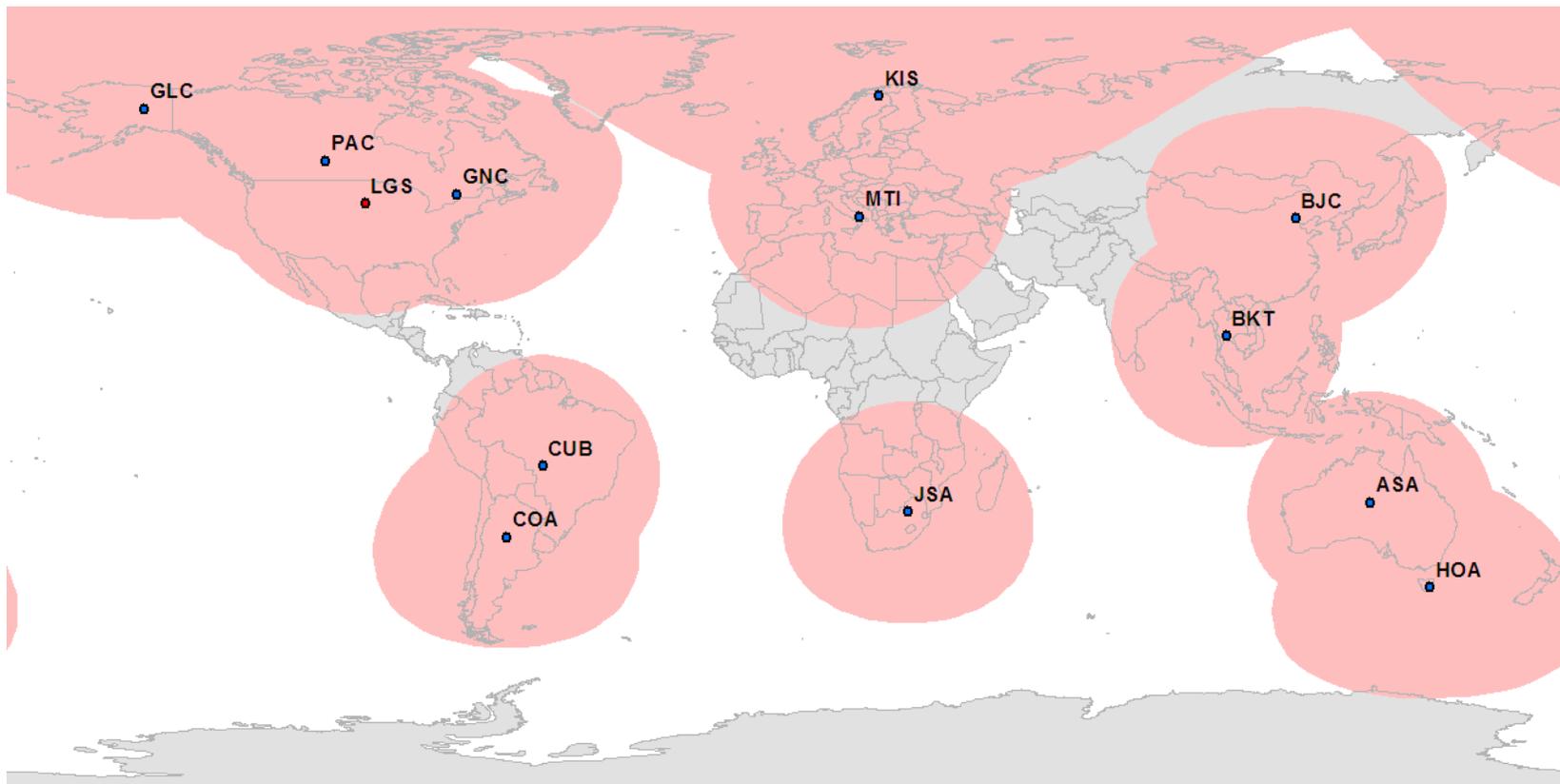
Yellow = L5 Coverage
Cyan = L7 Coverage

**>91% of the P/R
Locations Covered**

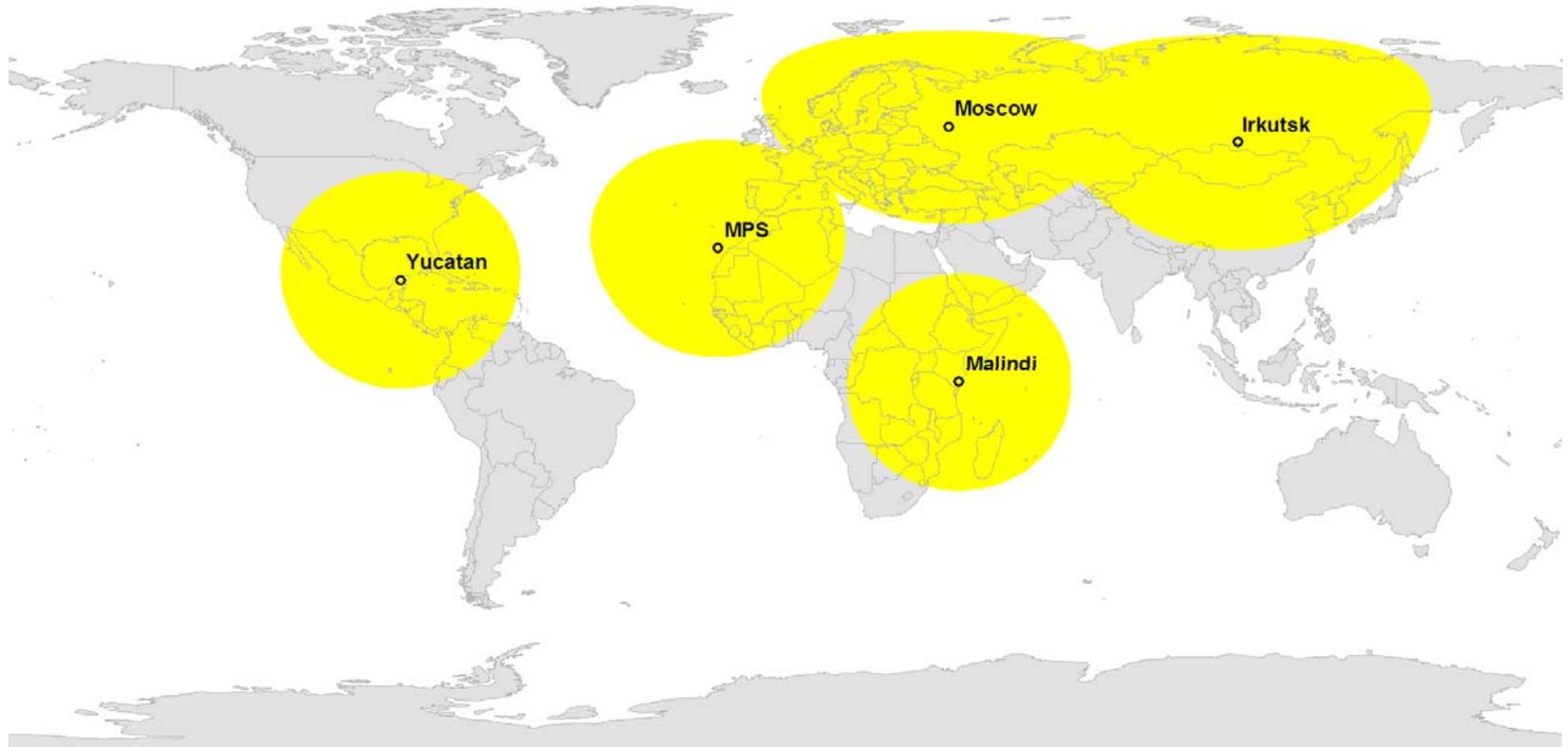
Landsat-5 IC Network Coverage



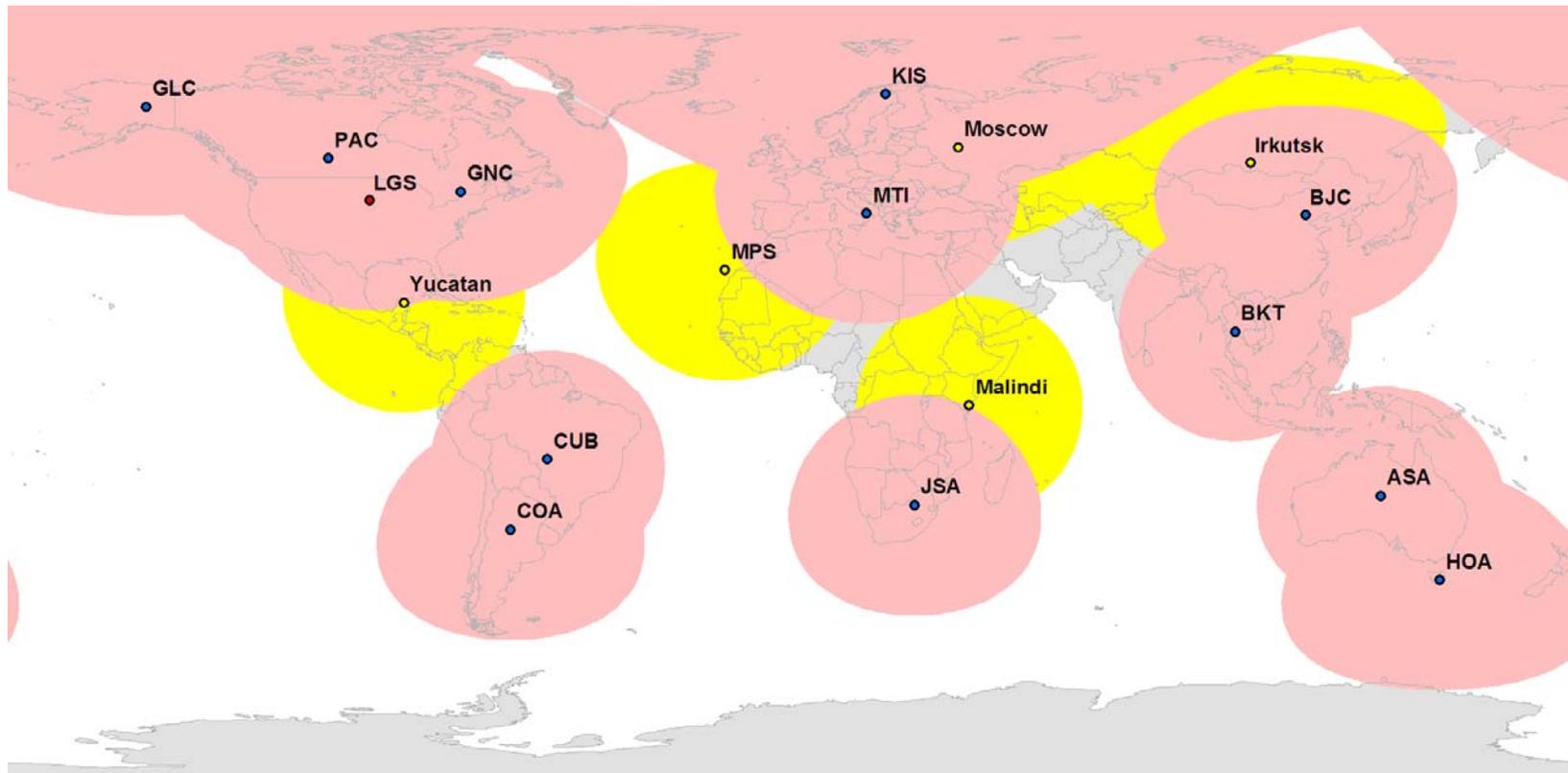
Current Landsat 5 Station Coverage



Notional Campaign Station Locations



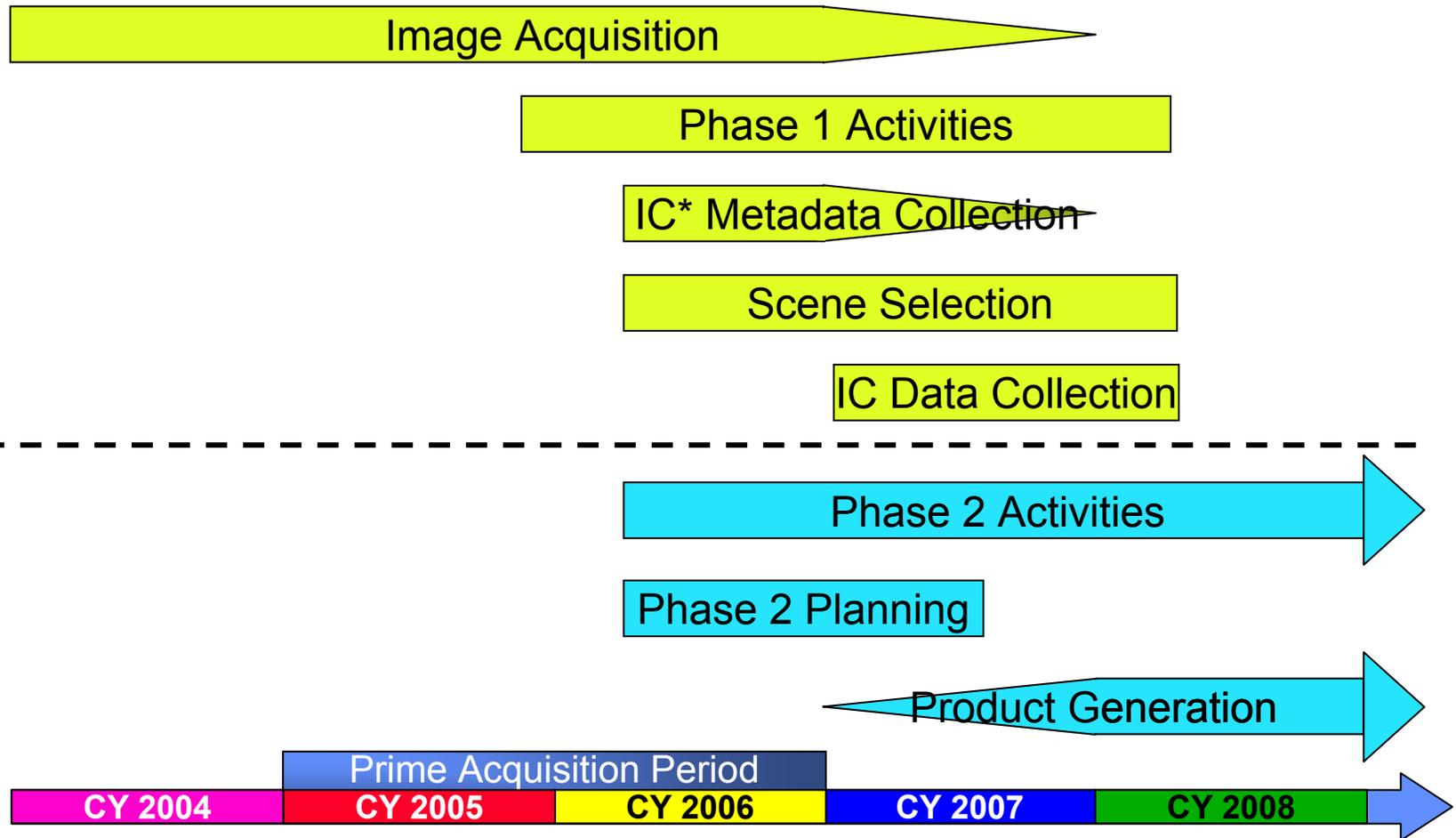
Resulting Global Coverage



Status of Foreign-Source Data

- **8 of 10 International Cooperators (IC) have agreed to support the MDGLS**
- **6 of 10 ICs have submitted metadata**
- **Campaign Station Status**
 - ◆ Kiruna (ESA) – Offline due to L5 Fixed-Array Con Ops. 72 tapes are at EROS to be ingested
 - ◆ Moscow and Irkutsk (ScanEx) – Stations are online and providing data operationally
 - ◆ Chetumal, Mexico (DLR) – Station under construction and due to begin operations in early 2007
 - ◆ Maspalomas (ESA) – Just beginning station certification.
 - ◆ Malindi (ESA) – Implementation schedule to be worked
 - ◆ Hobart (GeoScience Australia) – Coordinating data transfer

MDGLS Schedule



*IC = International Cooperator

Thank You

Mid-Decadal Global Land Survey (MDGLS)

Phase I: Identify and Acquire L5 and L7 Data

Phase II: Process MDGLS Data

Phase III: Analyze MDGLS Dataset for Land Cover/
Land Cover Change

Phase II Tasks

- Select data source and scenes (where multiple options are available)
- Process selected data
 - L0R -> L1G (systematic calibration)
 - Orthorectification
 - Gap-filling (for Landsat-7)
- Distribute MDGLS data

Complete dataset available Fall 2008

Data Source Selection: Issues

Landsat-7

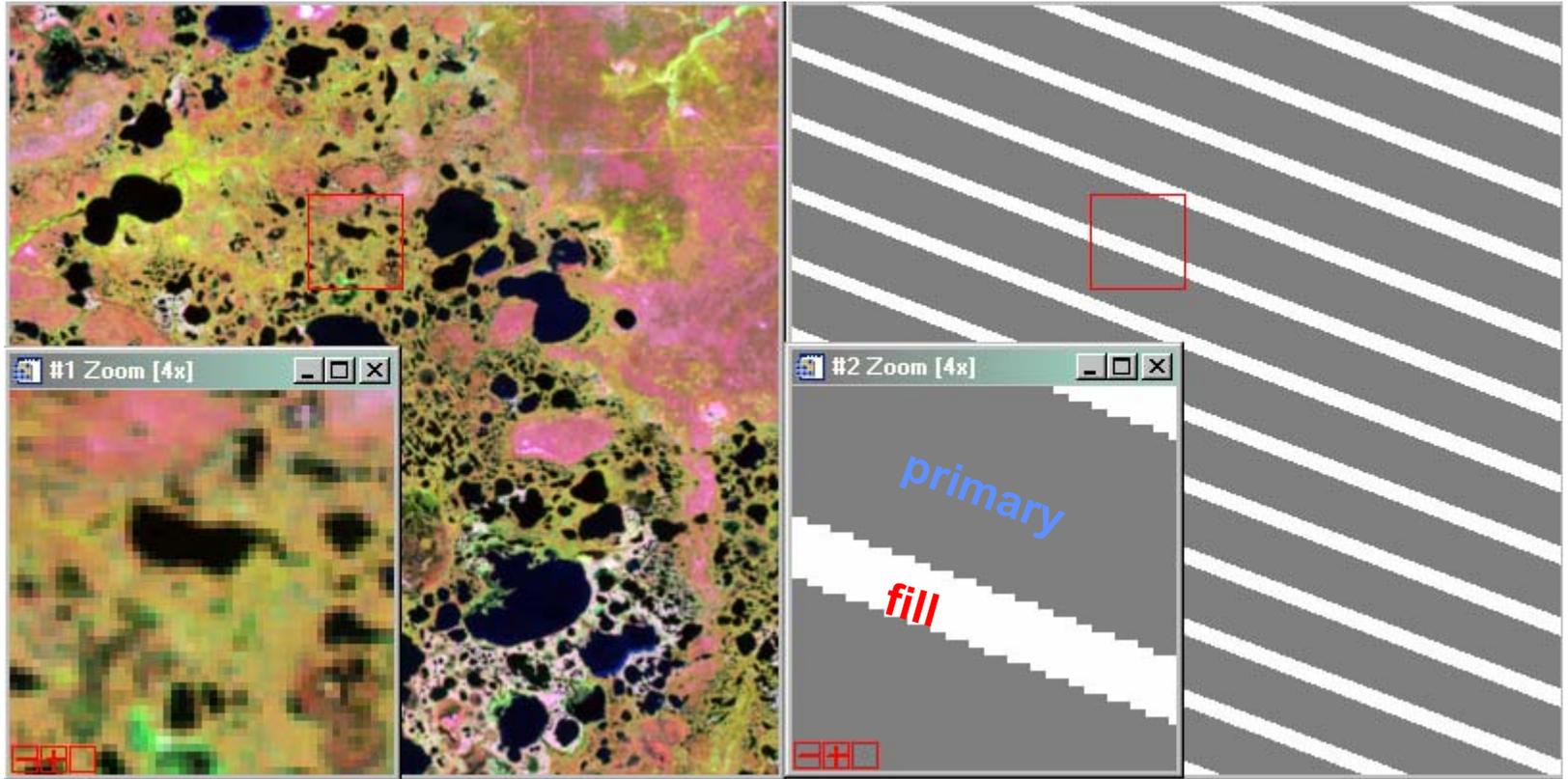
- Better radiometry
- 60m TIR band, pan band
- Gaps can be filled in cloud-free conditions

Landsat-5

- No gaps
- L7 gap filling can result in radiometric artifacts
- L5 calibration improved for ~2000 to present

Landsat-7 Gap-filling: The Good

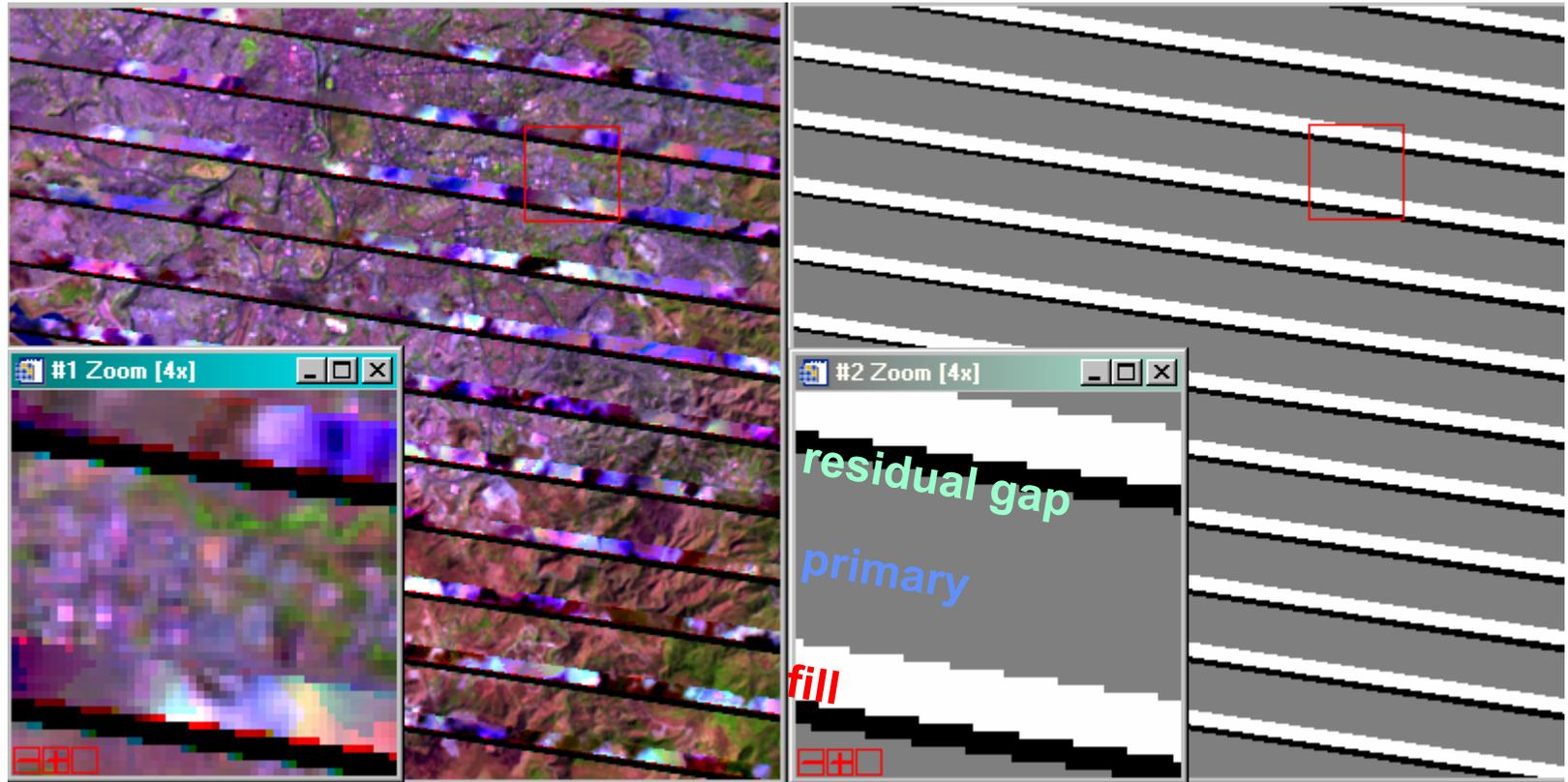
Northern Siberia (p159r15)



EROS Gap-filling works very well in cloud free conditions

Landsat-7 Gap-filling: The Bad and the Ugly

Honduras (p18r50)



Gap-filling with cloudy scenes can introduce radiometric artifacts; small residual gaps are possible

Data Source Selection: Status

Steering group is testing ETM+ gap filled data products for change detection. Report to LDCM Science Team in November.

- *Jim Vogelmann – mapping pivot irrigation*
- *Matt Hansen – tropical deforestation*
- *Chengquan Huang – temperate forest disturbance*
- *Jeff Masek – urban growth*

Likely to recommend mixed data sources:

Cloud-free (<~2% CC) scenes: lean toward Landsat-7 ETM+

Cloudier scenes: lean toward Landsat-5 TM

Humid Tropics: multiple ETM+ acquisitions for compositing?

Sensor choice must be balanced against acquisition date, overall cloud cover, and acquisition date of 2000 Geocover to make final selection

- AI algorithm being investigated to assist selection

MDGLS Product Specification (Draft)

- UTM / WGS-84 projection
- 14.25 / 28.5/ 57 meter resolution
- Cubic Convolution resampling (1 step)
- GeoTiff format
- Orthorectified (see next slide)

Processing by USGS EROS

FTP distribution of individual MDGLS scenes at no cost, with limited provision for bulk distribution of entire dataset (e.g. via hard disk transfer).

ETM+ Gap Filling Options

ETM+ data used will consist of 2 images, from within the same growing season, that fill >98% of the image area.

Option 1: Distribute 2 scenes separately; let users merge them.

Option 2: Distribute the gap-filled product. Primary scene can be recovered by applying gap-mask, included in product

Option 3: Distribute gap-filled product and (separately) fill scene.

MDGLS Orthorectification

Recommend use of 2000 GeoCover chips as geodetic control, SRTM 30/90m for terrain correction

- L7 automated 1Gt processing available Jan 2007
- L5 automated 1Gt processing available late 2007

Also recommend pursuing improved geodetic control library prior to LDCM launch, followed by reprocessing of previous GeoCover datasets to maintain continuity with LDCM.