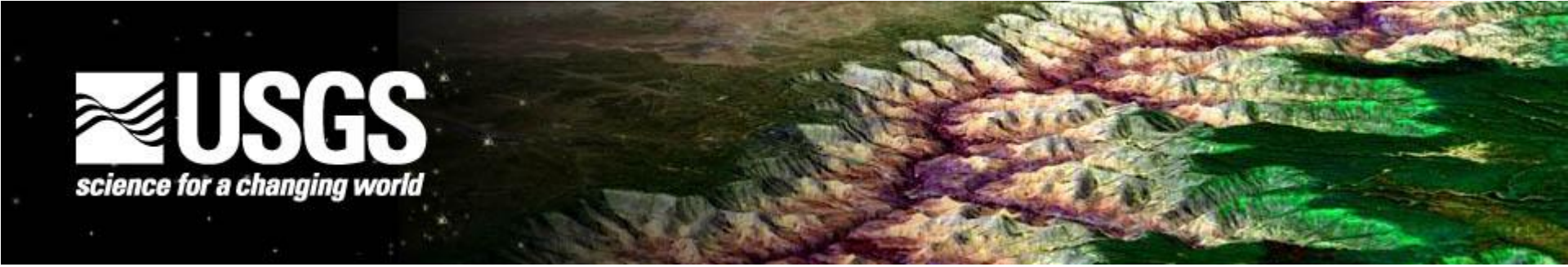

Landsat Project Status
Landsat Science Team Meeting

March 2011

Kristi Kline, PMP
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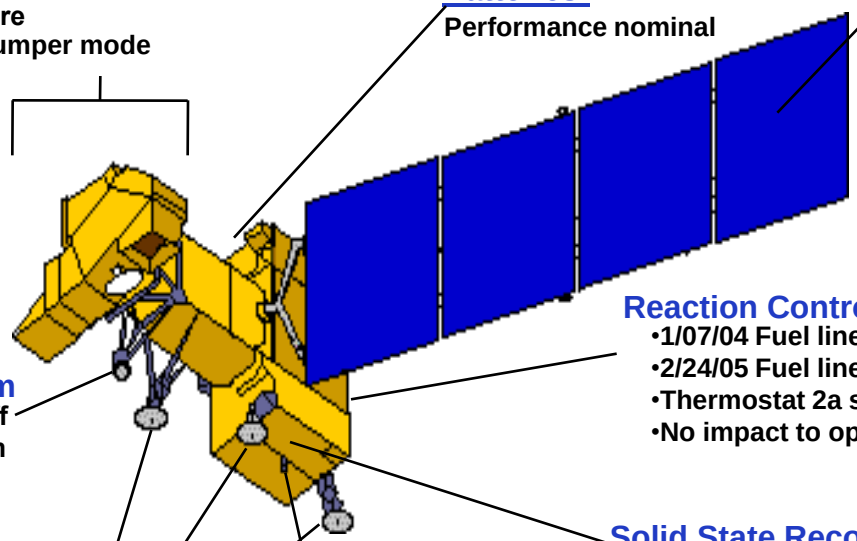
U.S. Department of the Interior

U.S. Geological Survey

Landsat 5 and 7 Status

Spacecraft Status

≈ 11 years of on-orbit operations



Enhanced Thematic Mapper +
- 5/31/2003 SLC Failure
- 4/01/2007 SAM -> Bumper mode

Electrical Power System

Batteries:
Performance nominal

Solar array:
- 5/14/2002 Circuit #14 Failure
- 5/16/2005 Circuit # 6 Failure
- 8/13/2008 Circuit #14 partial recovery
- 14 circuits remain operating
- no impact to ops

Reaction Control System
- 1/07/04 Fuel line #4 thermostat #1a failure
- 2/24/05 Fuel line #4 thermostat #1b failure
- Thermostat 2a shows signs of failure
- No impact to ops; extended plan in place

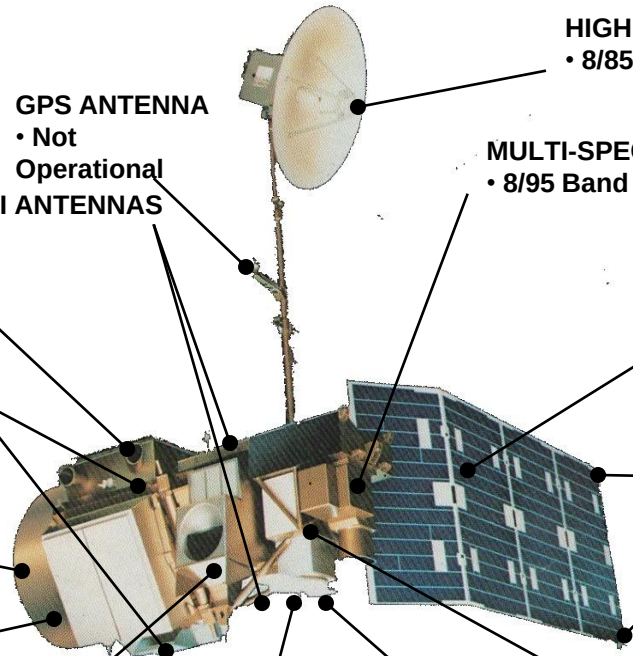
Attitude Control System
- 05/05/2004 Gyro 3 Shut Off
- Singe gyro control system in development

Solid State Recorder
- 11/15/1999 SSR PWA #23 Loss
- 02/11/2001 SSR PWA #12 Loss
- 12/07/2005 SSR PWA #02 Loss
- 08/02/2006 SSR PWA #13 Loss
- 03/28/2008 SSR PWA #22 Loss
- 09/03/2008 SSR PWA #23 Recovered
- Each PWA is 4% loss of launch capacity
- Boards are likely recoverable

X-band System
Performance nominal

S-band System
Performance nominal

Landsat 5 Flight Segment



HIGH GAIN ANTENNA
- 8/85 Transmitter A failure

GPS ANTENNA
- Not Operational

OMNI ANTENNAS

COMM & DATA HANDLING MODULE
- Located back side of s/c

ACS MODULE
- 07/03 FHST#1 Degradation
- Skew wheel tack anomaly 10/92
- 11/92 Earth Sensor 1 failure
- 02/02 Earth Sensor 2 failure
- Intermittent operations possible
- 08/09 Gyro-C anomaly
- 09/09 Gyro A&B Prime configuration

PROPULSION MODULE
- 3/84 Primary Thruster D failure

POWER MODULE
- 05/04 Battery-1 failure / Removed from power circuits
- 10/07 Battery-2: 1 of 22 Cells fails

THEMATIC MAPPER
- 10/94 Power Supply 1 stuck switch
- 06/02 TM switched to bumper mode

MULTI-SPECTRAL SCANNER
- 8/95 Band 4 failure

SOLAR ARRAY DRIVE / PANELS
- 01/05 Primary Solar Array Drive failure
- Nominal Solar array panel degradation (12/04)
- 11/05 Redundant Solar Array Drive Malfunction

COARSE SUN SENSORS

X-BAND ANTENNA

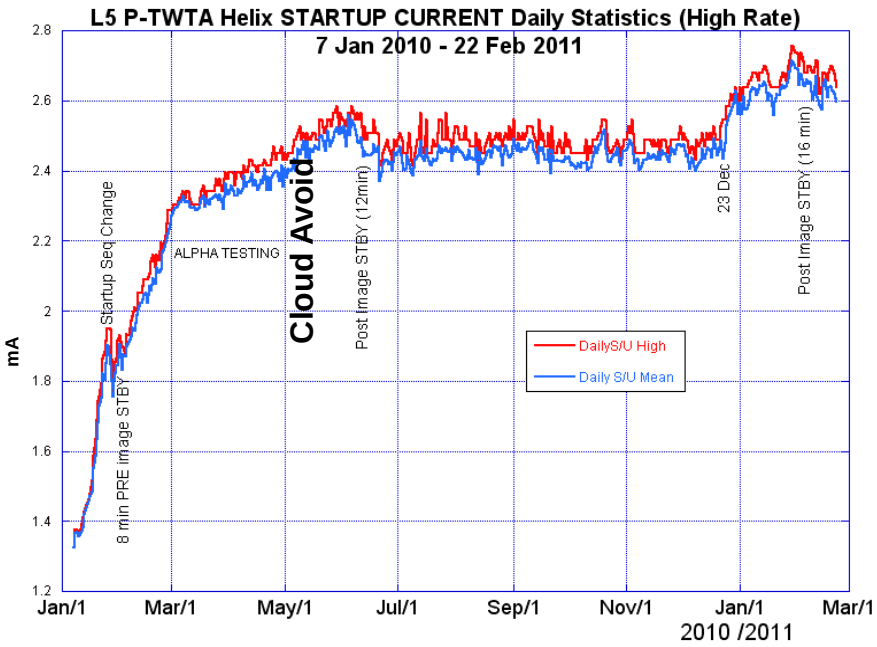
WIDEBAND COMM. MODULE
- 07/88 Ku-band TWTA Prime failure (OCP)
- 07/92 Ku-band TWTA Redundant failure (OCP)
- 08/87 X-band TWTA Prime failure (OCP)
- 03/06 X-band TWTA Redundant Anomaly
- 12/09 X-band TWTA Redundant Failure (OCP)
- 01/10 X-band TWTA Prime successfully Recovered

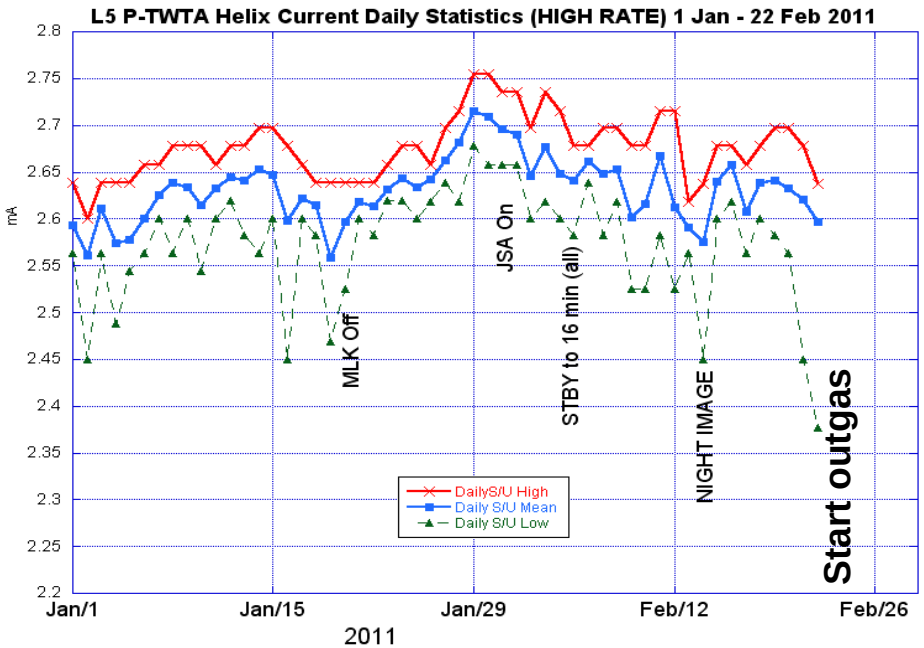
DIRECT ACCESS S-BAND
- 03/94 Side A FWD Power Sensor failure

Landsat 5 Activities Summary

- **Night image collection**
  - One image collected (over water)
  - Lake Tahoe planned for collection to improve calibration
- **TM outgassing successfully completed (Feb 22-24)**
- **TWTA (Traveling Wave Tube Amplifier)**
  - Primary TWTA failed in 1987 when current hit “trip” state
  - Redundant TWTA operated 22 years until 12/2009
    - Primary TWTA brought back on-line Jan 2010
  - Helix current (measure of tube health) began period of instability in late December after 6 months of relative quiet
  - Three new highs over the past few weeks heighten concern

TWTA Operational Status 2/23/11



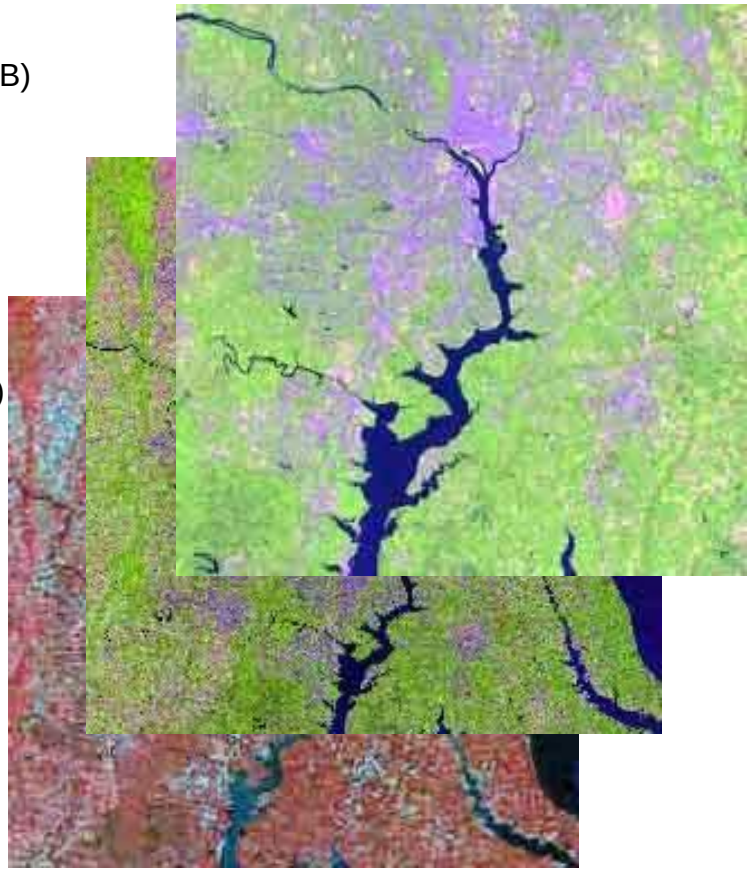


Landsat Archive and Processing Topics

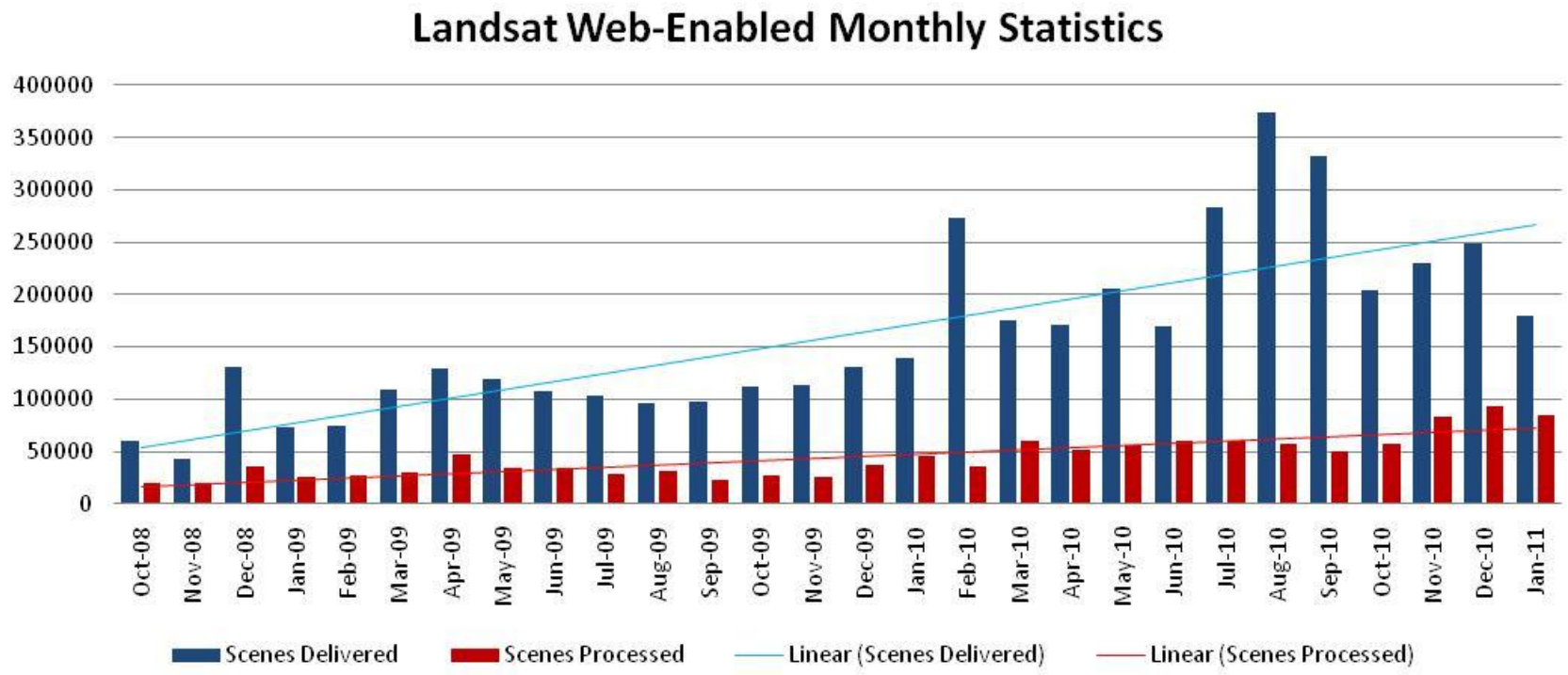
U.S. Landsat Archive Overview

(February 1, 2011)

- **ETM+: Landsat 7**
  - 1,114,722 scenes available to the public
    - ~1,034 TB Raw and L0Ra Data (average scene size 487 MB)
  - 1,638,781 scenes in the archive
    - 598 TB Raw Data
    - 584 TB L0Ra Data
    - Archive grows by ~260 GB Daily
- **TM: Landsat 4 & Landsat 5**
  - 995,232 scenes available to public
    - ~498 TB Raw and L0Ra Data (average scene size 263 MB)
  - 1,274,073 scenes in the archive
    - 313 TB Raw Data
    - 287 TB L0Ra Data
    - Archive grows by ~ 80 GB Daily
- **MSS: Landsat 1 through 5**
  - 615,743 scenes available to public
    - ~18 TB Raw and L0Ra Data (average scene size 32 MB)
  - 1,115,126 scenes in the archive
    - 18 TB Raw Data
    - 27 TB L0Ra Data



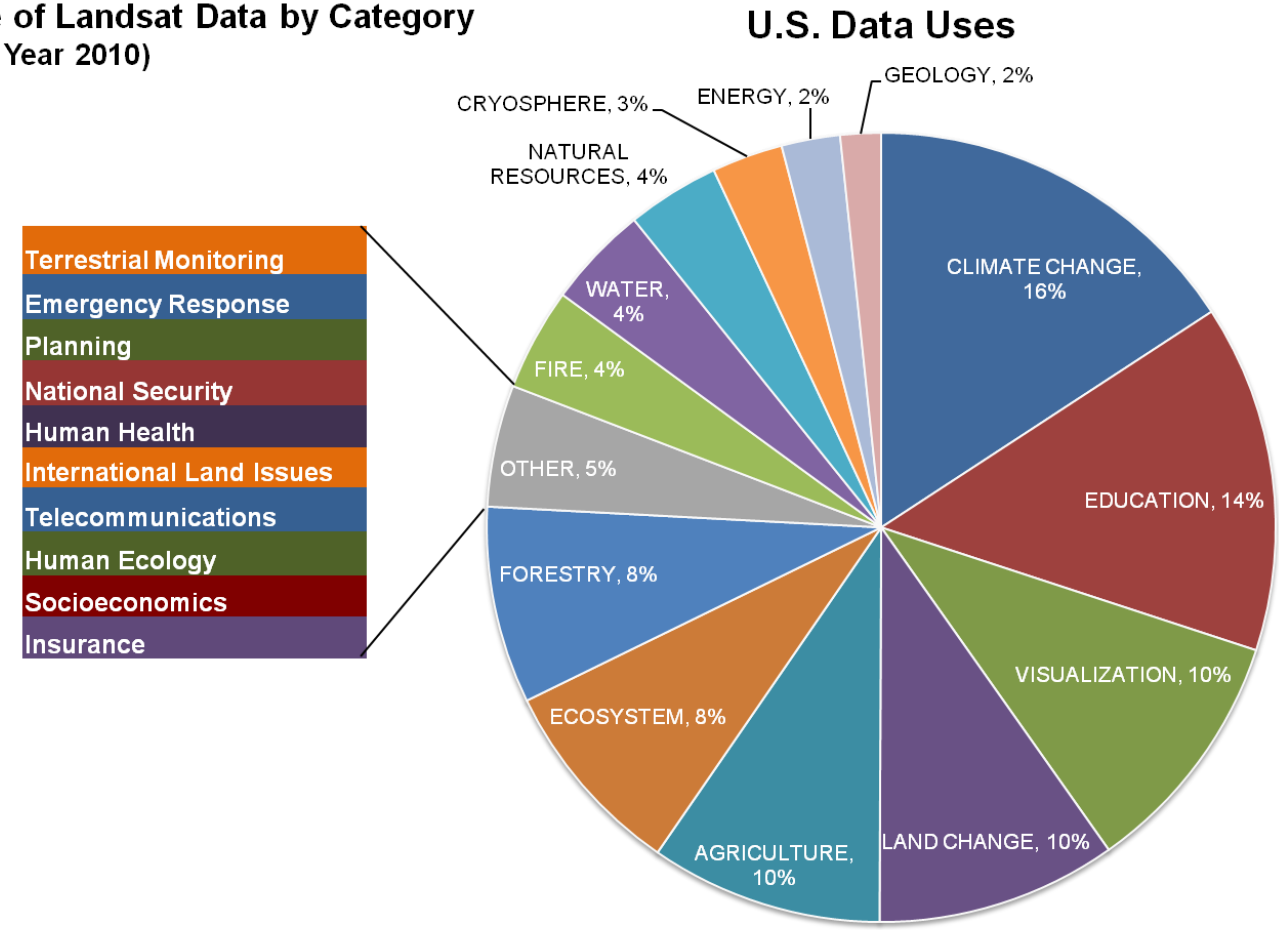
Monthly Downloads / Processed



- **FY09 (Oct 2008 – Sep 2009)**
  - Delivered: 1.14M
  - Processed: 358K
- **FY10 (Oct 2009 – Sep 2010)**
  - Delivered: 2.48M
  - Processed: 567K
- **FY11 (Oct 2010 – Jan 2011)**
  - Delivered: 862K
  - Processed: 319K

FY2010 Landsat U.S. Data Use

U.S. Customers:
% Use of Landsat Data by Category
(Fiscal Year 2010)



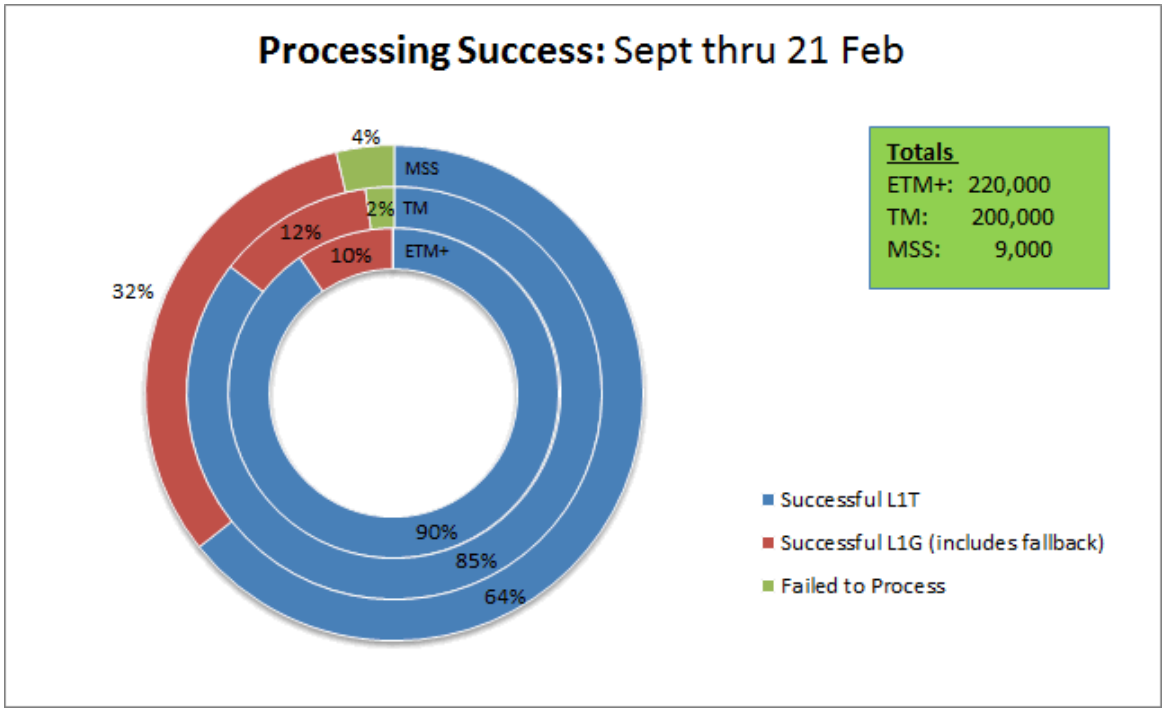
Project Activities and Status

- **Archive migration**
  - Migrating all Landsat data to new tape archive unit and copy to on-line disk storage
  - Old tape archive obsolete technology
  - On-line storage will help increase processing throughput

Sensor	Migration to New Tape Media	Migration to On-line Disk
MSS	100%	100%
TM	100%	28%
ETM+	43%	12%

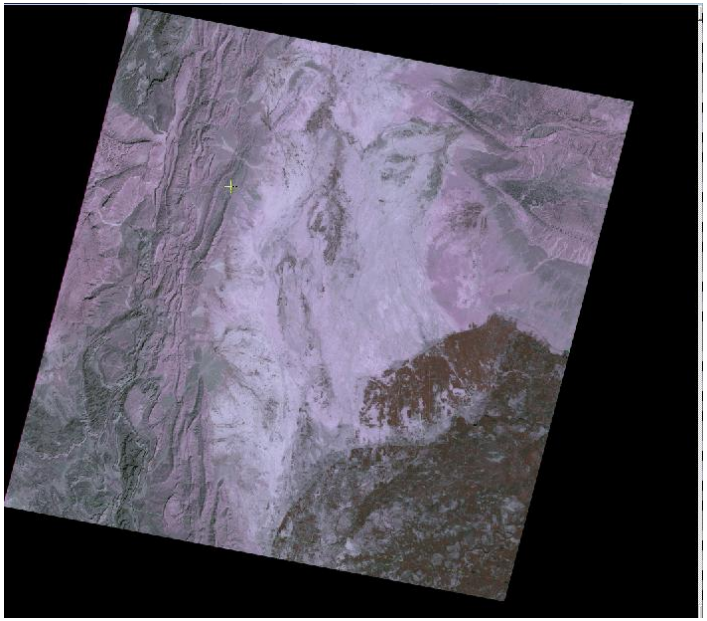
Project Activities and Status

- **Processing Enhancements**
  - Released MSS on LPGS in September 2010
  - Working on absolute calibration enhancements/campaign for MSS
  - Enhancements for TM (Gaussian Pyramid) geometric processing
  - Improvements for L1T processing
  - Full resolution browse available
  - Processing throughput

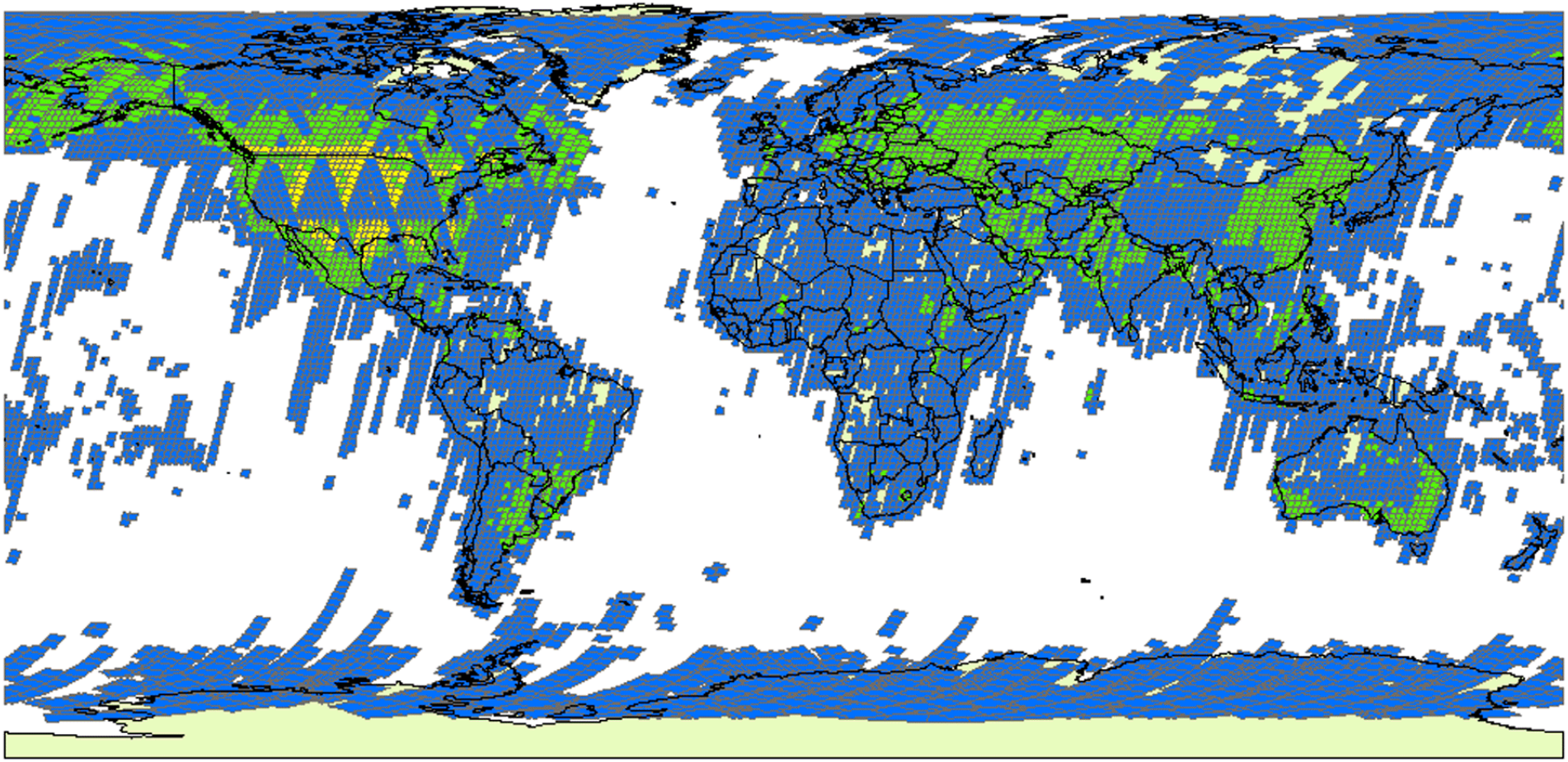


Landsat MSS Orphans

- **What is an MSS Orphan?**
  - Intervals of L1-3 data that are missing ephemeris information (scene center, lat/lon, spacecraft atitude, sun elevation/azimuth, sensor gain, etc.)
  - Ephemeris data store on separate tape (9-track) during that era
- **Completed recovery of the orphan data!**
  - Over 170,000 full scenes recovered
  - 106,335 NEW scenes added to the US archive

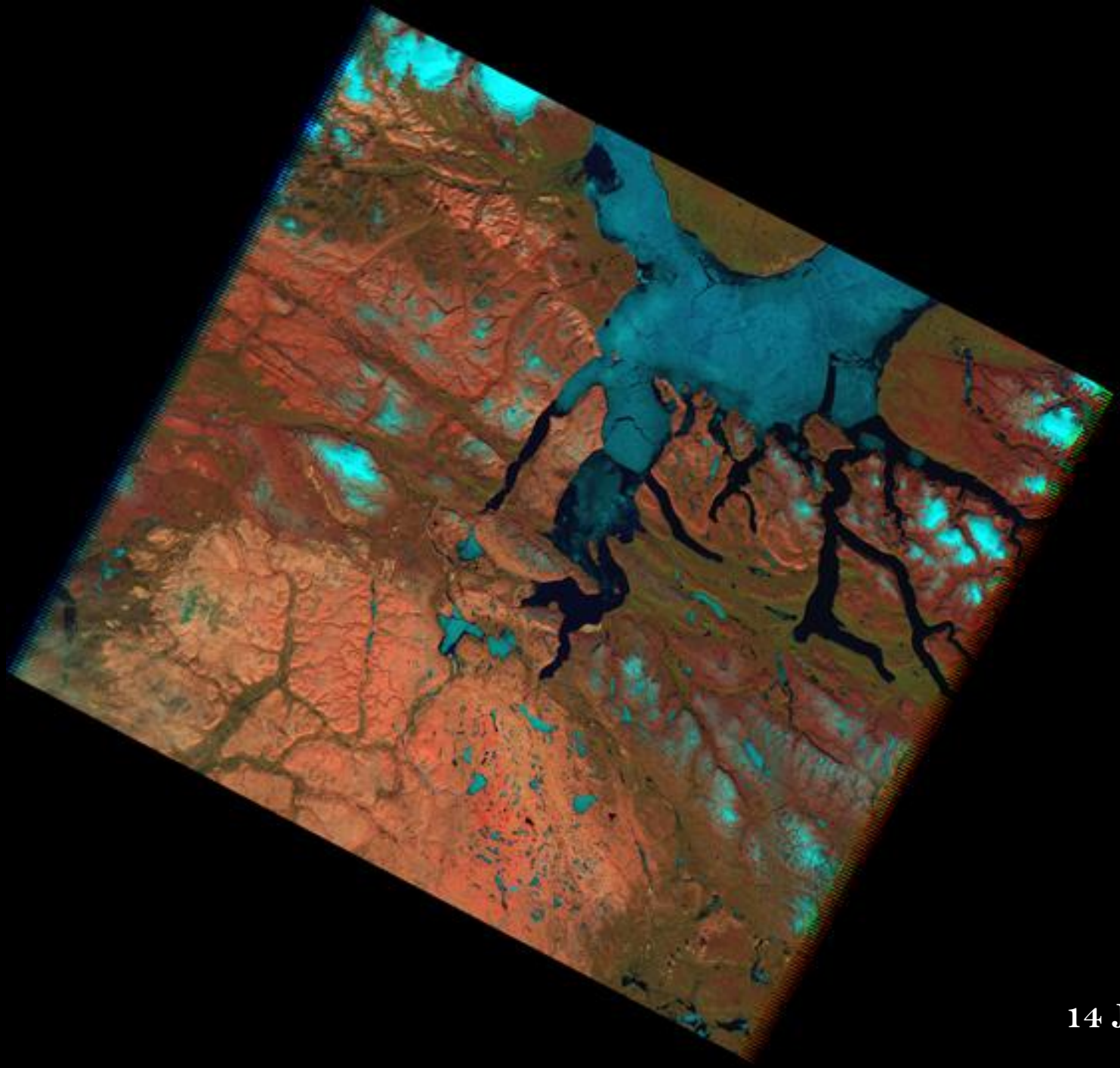


Landsat 1-3 MSS Total New Scenes
Scenes Never Before Seen and Scenes that Replace Film Source



Aquisition Date Range: July 25, 1972 through March 02, 1983
106,335 Total L1-3 MSS New Scenes
35,239 (33%) Total L1-3 MSS Scenes Never Before Seen
71,096 (67%) Total L1-3 MSS Scenes that Replace Film Source
14,374 Unique L1-3 MSS Path/Rows of New Scenes

1 - 9 | 10 - 49 | 50 - 149



14 July 2006

The Woodcock Metric

297,790

56% CCRS

This effort made possible by …

- USGS Land Remote Sensing
- NASA GSFC Landsat Project Science Office
- USGS Data Rescue

Goals & Assumptions

- **Repatriate all internationally-acquired Landsat data**
- **Each station has data that will enhance the USGS archive**
  - In the short term, some data may have higher science priorities
  - Each station has technical and non-technical challenges

Status

Station	# in 1k's	%	Contact	Meta-data	Test Data	Technical Eval			Agree-ment	Archive Req	Data Recd
						MSS	TM	ETM+			
Europe (ESA)	2,090	42%									
Australia (GA-NEO)	629	13%									
Canada (CCRS)	532	11%									
China (CEODE)	449	9%									
Japan (RESTEC)	275	6%									
Brazil (INPE)	234	5%									
Argentina (CONAE)	195	4%				N/A					
South Africa (CSIR-SAC)	154	3%									
Thailand (GISTDA)	90	2%									
Germany (DLR) @ESA	87	2%				N/A	N/A				
Saudi Arabia (KACST MAW)	69	1%				N/A		N/A			
India (NRSA)	51	1%						N/A			
US (U of Puerto Rico)	42	1%				N/A	N/A				
Ecuador (CLIRSEN)	40	1%				N/A		N/A			
Pakistan (SUPARCO)	24	<1%				N/A		N/A			
Japan (HIT)	21	<1%				N/A	N/A				
Indonesia (LAPAN)	8	<1%				N/A					

Status: Science Team Interests

Station	# in 1k's	%	Contact	Meta-data	Test Data	Technical Eval			Agree-ment	Archive Req	Data Recd
						MSS	TM	ETM+			
Europe (ESA)	2,090	42%									
Australia (GA-NEO)	629	13%									
Canada (CCRS)	532	11%									
China (CEODE)	449	9%									
Japan (RESTEC)	275	6%									
Brazil (INPE)	234	5%									
Argentina (CONAE)	195	4%				N/A					
South Africa (CSIR-SAC)	154	3%									
Thailand (GISTDA)	90	2%									
Germany (DLR) @ESA	87	2%				N/A	N/A				
Saudi Arabia (KACST MAW)	69	1%				N/A		N/A			
India (NRSA)	51	1%						N/A			
US (U of Puerto Rico)	42	1%				N/A	N/A				
Ecuador (CLIRSEN)	40	1%				N/A		N/A			
Pakistan (SUPARCO)	24	<1%				N/A		N/A			
Japan (HIT)	21	<1%				N/A	N/A				
Indonesia (LAPAN)	8	<1%				N/A					

Status: Top 75%

Station	# in 1k's	%	Contact	Meta-data	Test Data	Technical Eval			Agree-ment	Archive Req	Data Recd
						MSS	TM	ETM+			
Europe (ESA)	2,090	42%									
Australia (GA-NEO)	629	13%									
Canada (CCRS)	532	11%									
China (CEODE)	449	9%									
Japan (RESTEC)	275	6%									
Brazil (INPE)	234	5%									
Argentina (CONAE)	195	4%				N/A					
South Africa (CSIR-SAC)	154	3%									
Thailand (GISTDA)	90	2%									
Germany (DLR) @ESA	87	2%				N/A	N/A				
Saudi Arabia (KACST MAW)	69	1%				N/A		N/A			
India (NRSA)	51	1%						N/A			
US (U of Puerto Rico)	42	1%				N/A	N/A				
Ecuador (CLIRSEN)	40	1%				N/A		N/A			
Pakistan (SUPARCO)	24	<1%				N/A		N/A			
Japan (HIT)	21	<1%				N/A	N/A				
Indonesia (LAPAN)	8	<1%				N/A					

Status: Significant Issues

Station	# in 1k's	%	Contact	Meta-data	Test Data	Technical Eval			Agree-ment	Archive Req	Data Recd
						MSS	TM	ETM+			
Europe (ESA)	2,090	42%									
Australia (GA-NEO)	629	13%									
Canada (CCRS)	532	11%									
China (CEODE)	449	9%									
Japan (RESTEC)	275	6%									
Brazil (INPE)	234	5%									
Argentina (CONAE)	195	4%				N/A					
South Africa (CSIR-SAC)	154	3%									
Thailand (GISTDA)	90	2%									
Germany (DLR) @ESA	87	2%				N/A	N/A				
Saudi Arabia (KACST MAW)	69	1%				N/A		N/A			
India (NRSA)	51	1%						N/A			
US (U of Puerto Rico)	42	1%				N/A	N/A				
Ecuador (CLIRSEN)	40	1%				N/A		N/A			
Pakistan (SUPARCO)	24	<1%				N/A		N/A			
Japan (HIT)	21	<1%				N/A	N/A				
Indonesia (LAPAN)	8	<1%				N/A					

Status: Questions?

Station	# in 1k's	%	Contact	Meta-data	Test Data	Technical Eval			Agree-ment	Archive Req	Data Recd
						MSS	TM	ETM+			
Europe (ESA)	2,090	42%									
Australia (GA-NEO)	629	13%									
Canada (CCRS)	532	11%									
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Pakistan (SUPARCO)	24	<1%				N/A		N/A			
Japan (HIT)	21	<1%				N/A	N/A				
Indonesia (LAPAN)	8	<1%				N/A					

Interesting Bits

- **Timelines**
  - Multiple-year effort for archive transcriptions
    - Canada: started in August, complete this summer
    - Argentina: estimates 18 months
- **New Acquisitions**
  - Not just historical archives!
- **EROS Technical**
  - Converters planned or in-work for Australia, Indonesia, & Japan
  - Baking underway for Indonesia tapes
    - More severe damage than originally thought

The Way Forward

- **Request data from willing ICs**
  - Prioritize based on Science Need
- **Pursue current opportunities**
  - Take advantage of new ones that arise
- **Continue working with all stations**
  - Recognizing
    - MSS data is likely the most threatened
    - Most of the data is TM
    - Some political issues cannot be overcome: out of our control
    - Some technical issues may not be overcome, although at least we'll have made the attempt