

# **USGS Report to the CEOS WGCV 31**

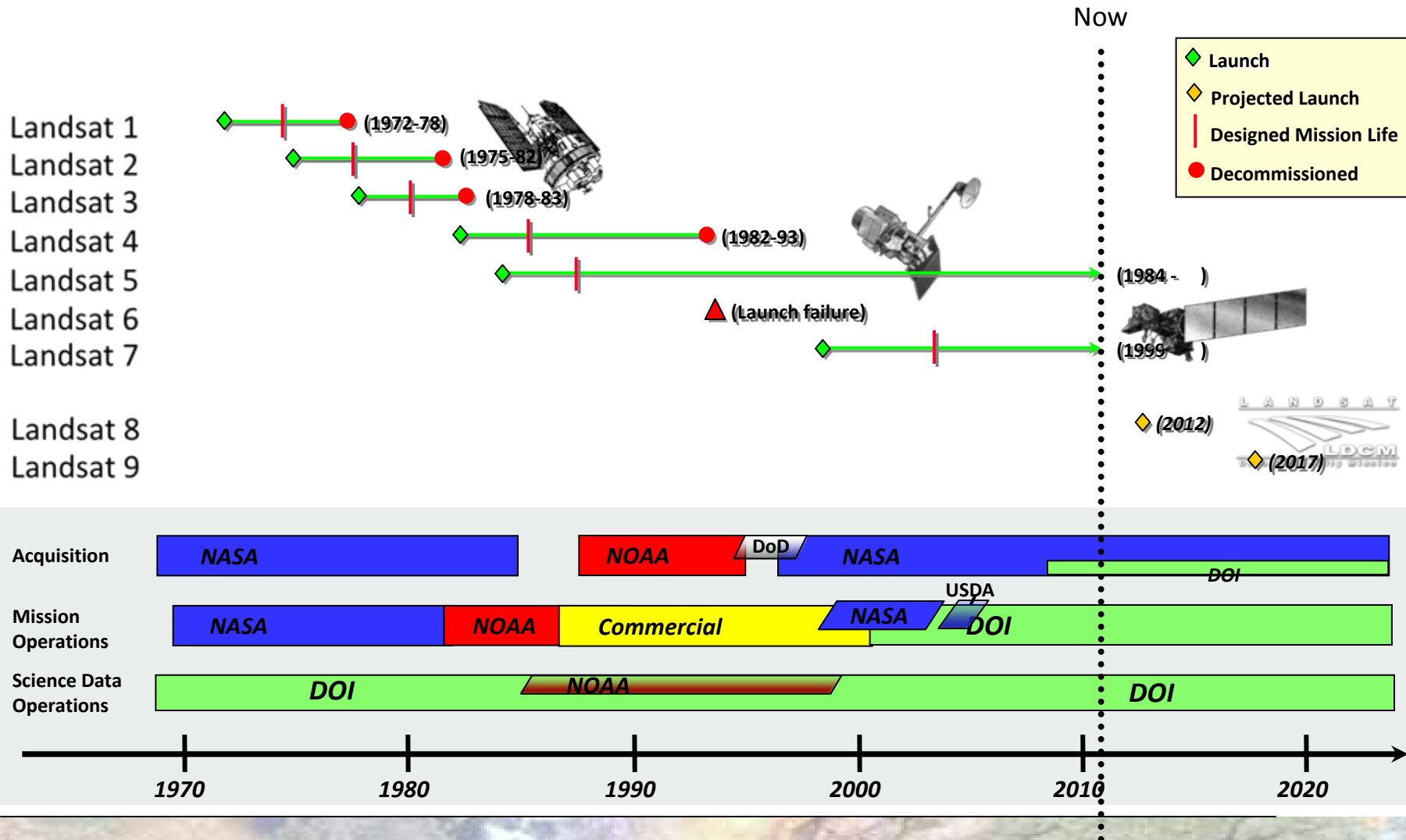
**March 2 – 5, 2010**

**Potomac, MD, USA**

**Greg Stensaas – USGS**  
**Gyanesh Chander – SGT/USGS**



# Landsat



# U.S. Landsat Archive Overview

(Available scenes through November 30, 2009)

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- **ETM+: Landsat 7**

- ◆ 990,735 scenes
- ◆ 920TB RCC and L0Ra Data
- ◆ Archive grows by 260 GB Daily

- **TM: Landsat 4 & Landsat 5**

- ◆ 843,787 scenes
- ◆ 211TB of L0Ra Data
- ◆ Archive Grows by 40 GB Daily

- **MSS: Landsat 1 through 5**

- ◆ 652,088 scenes
- ◆ 19 TB of Data



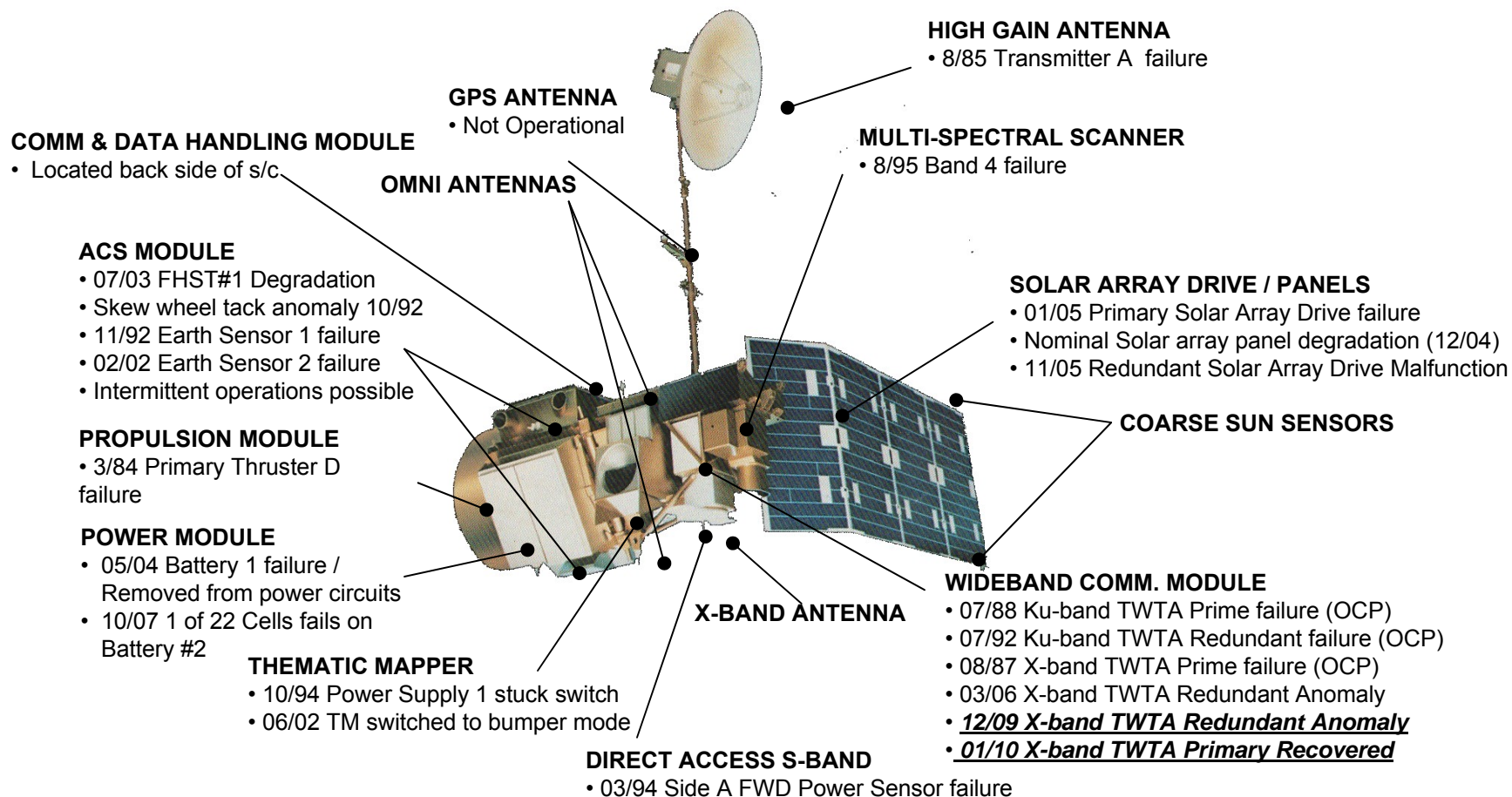
# Landsat 5 Mission Status

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- **Landsat 5 – 1 March 1984 (~26 years)**
  - ◆ L5 has exceeded 130,000 orbits!
  - ◆ Spacecraft
    - Battery 2 Anomaly – Oct 2007
    - Star Tracker Issue – June 2007
    - Solar Array Drive (Fixed array operations) – Aug 2006
    - Delta-Inclination maneuver completed (Nov 5, 2008)
  - ◆ TM
    - Functioning normally in bumper-mode
    - Outgassing of TM completed Jan 27-29, 2009

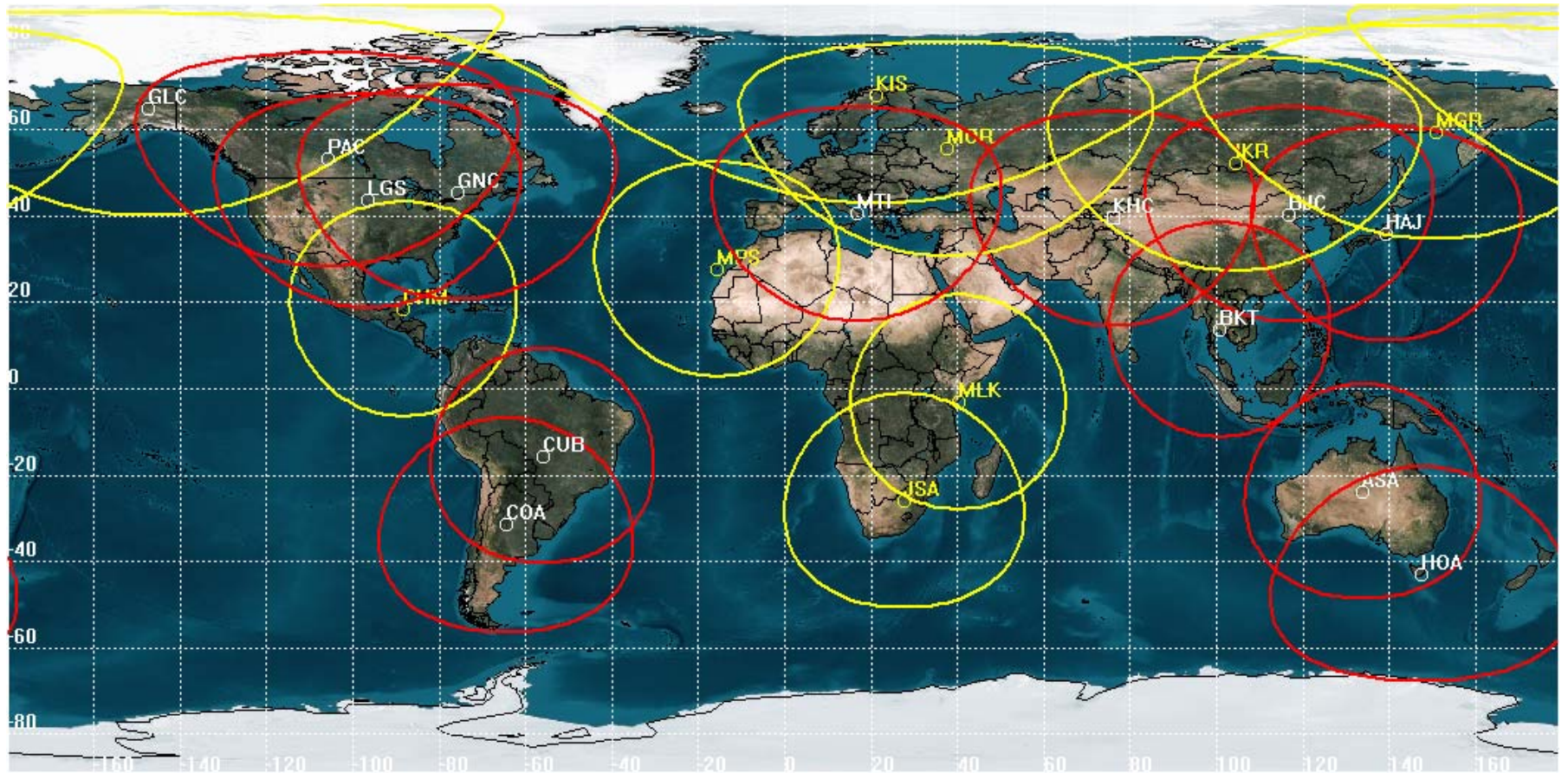


# Landsat 5 Flight Segment





# Landsat-5 Reception Network



# Landsat 5 TM Calibration Update

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- **Within-band within-scene internal stability**
  - ◆ Scan-Correlated Shift (SCS) of up to 0.7 DN
    - Correctable with scan line-by-scan line background subtraction
  - ◆ Memory effect of up to 4 DN
    - Currently corrected in NLAPS processing
  - ◆ Some banding and striping issues remain to be resolved
- **Between-date stability**
  - ◆ Interference cycling from icing on B5 and B7
    - Correctable with IC processing or LUT that includes interference cycling
- **Radiometric calibration processing**
  - ◆ Uses Gain Calibration History stored in Look-Up Table
  - ◆ Extracts and applies biases on a scan line by scan line basis
  - ◆ Rescaled to Fixed Radiance Range (LMIN, LMAX)
  - ◆ Look-up Table revised April 2, 2007 to reflect revised trends from Sahara desert site data obtained from ESA

# Landsat 5 TWTA Status

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- **Redundant Traveling Wave Tube Amplifier (TWTA) Failure (a downlink power amplifier for spacecraft telecommunications)**
- **Primary TWTA failed in 1987**
- **Switched to redundant TWTA soon afterwards**
- **On December 18th, 2009, the redundant TWTA completely failed (caused loss of science data; determined to be unrecoverable on December 23rd)**
  - ◆ Flight Operations Team prepared for recovery of the primary TWTA between December 18th and January 6th
  - ◆ The first successful science data downlink utilizing the primary TWTA on January 7th (L5 rises from the dead?)
  - ◆ Incrementally added IC ground stations January 11th – 15th
  - ◆ Operational on Jan 15th
  - ◆ Science data is considered “operational” with ongoing caveats



# Landsat 7 Mission Status

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- **Landsat 7 – 15 April 1999 (~11 Years)**

- ◆ 53,360 orbits

- ◆ Spacecraft

- Gyro 3 Failure (Shut down May 5, 2004)

- Other Spacecraft Issues (non-critical)

- ◆ Solid State Recorder (SSR) – PWA#22 Failure (Mar 28, 2008)

- ◆ SSR Recovery (Sep 3, 2008) – Recovered 1 of 5 failed board

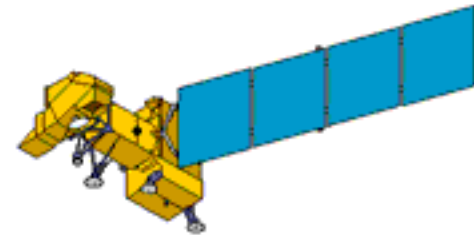
- ◆ Delta-Inclination maneuver completed (Oct 7, 2008)

- ◆ Additional Inclination maneuvers planned to extend mission life

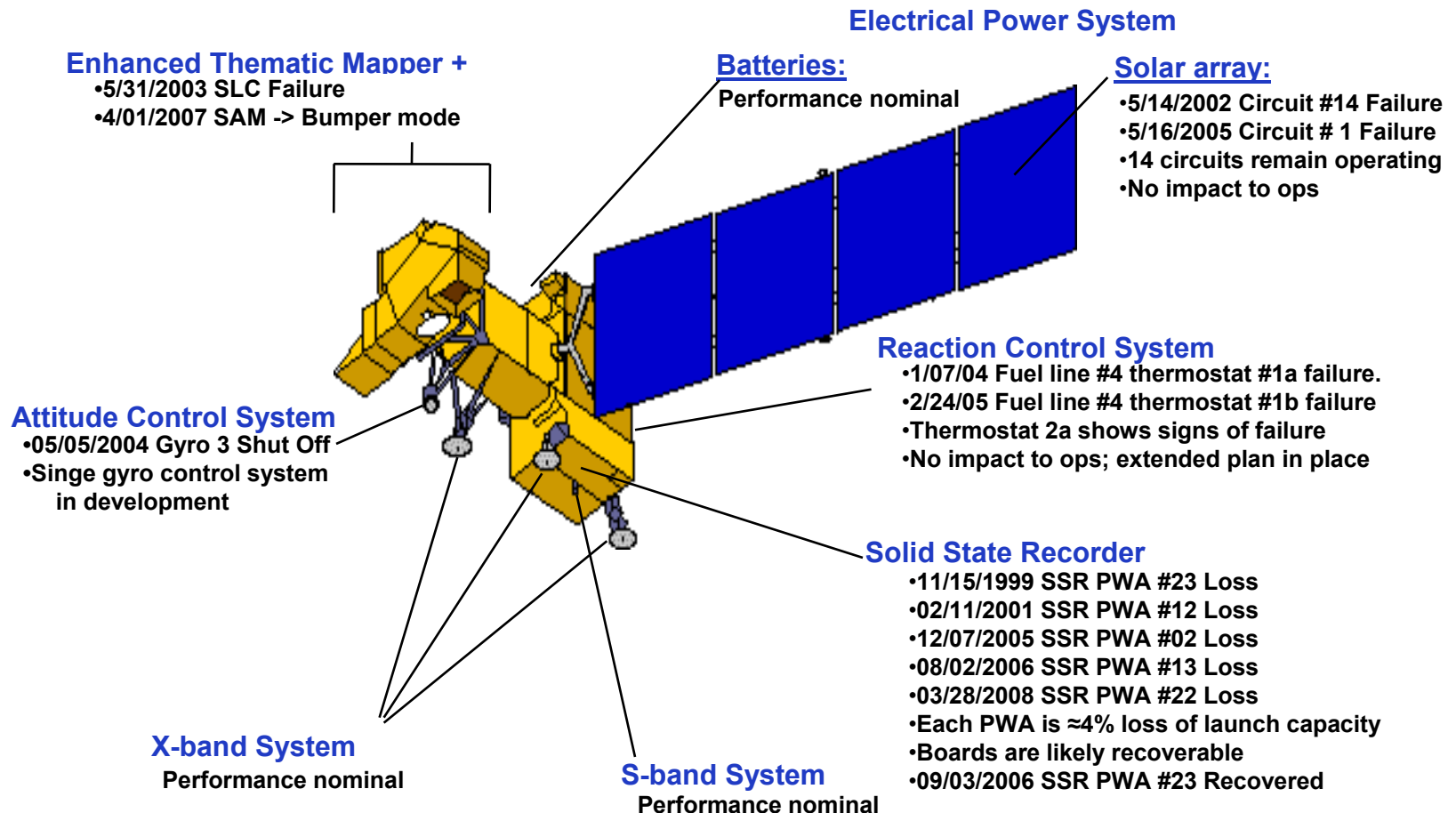
- ◆ ETM+

- Scan Line Corrector Failure (May 31, 2003)

- Bumper Mode Operations (April 1, 2007)

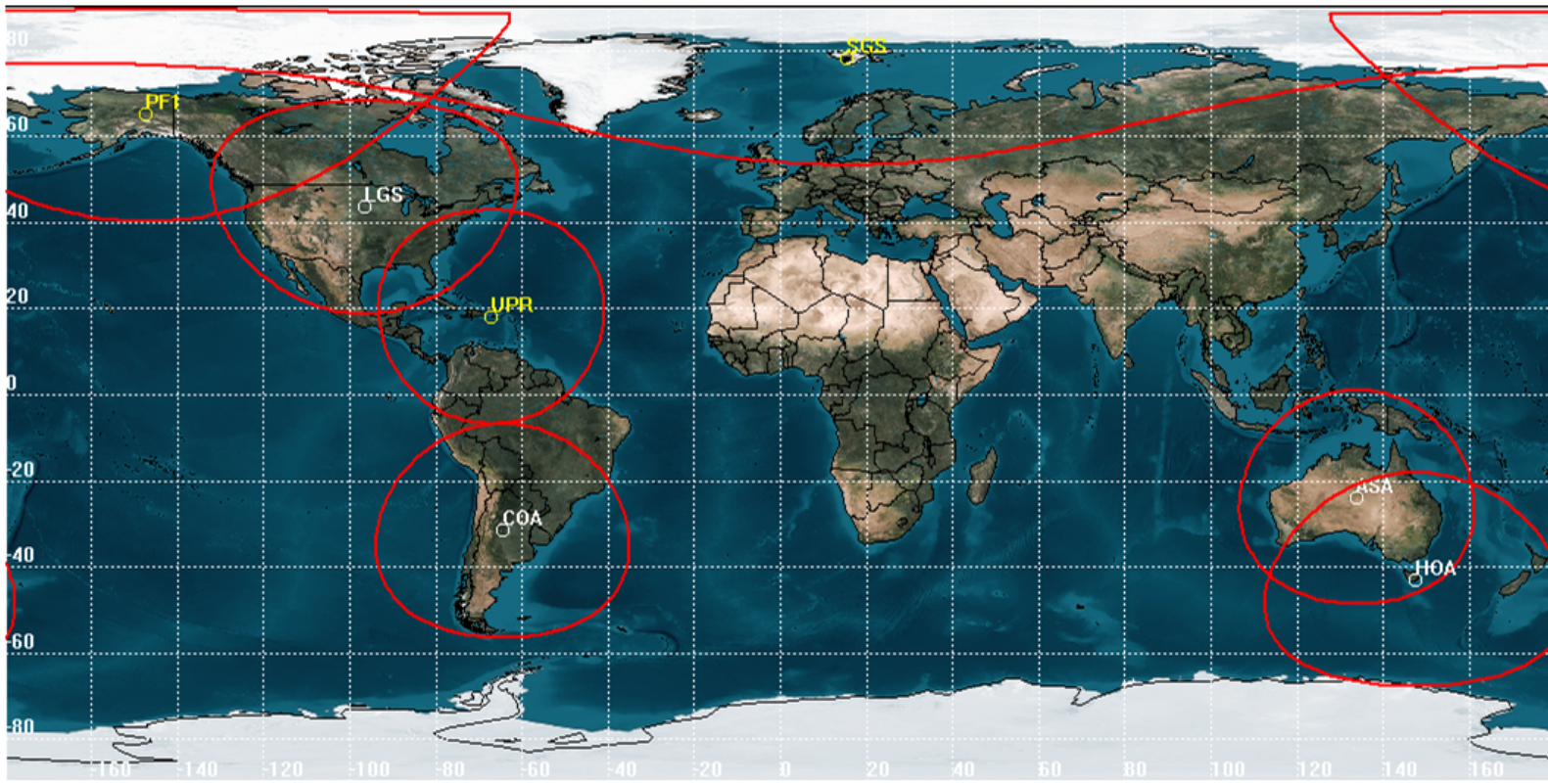


# Landsat 7 Flight Segment



# Landsat 7 Reception Network

- US Network: LGS, PF1, PF2, ASA
- Backup Network: SGS
- IGS Network: UPR, COA, HOA



# Landsat 7 Orbit

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- **On December 9<sup>th</sup>, Landsat 7 was predicted by the Joint Space Operations Center to have a close approach with Formosat 3D**
  - ◆ Unfortunately identified 1 day after L7 executed delta-i orbit maintenance maneuver
  - ◆ On the 10<sup>th</sup>, the probability was about 1.2% with a miss distance predicted at 125m to 250m
  - ◆ On the 11<sup>th</sup>, the probability of collision had grown to 2.28% and the miss distance dropped to 95m
- **Later on the 11<sup>th</sup>, L7 executed a 2.5 second posi-grade burn, removing the risk of collision**
  - ◆ The best option would have been a retro-grade avoidance maneuver, but not worth the risk
- **No impact to end-of-life (EOL) from this maneuver**



# Landsat 7 ETM+ Calibration Update

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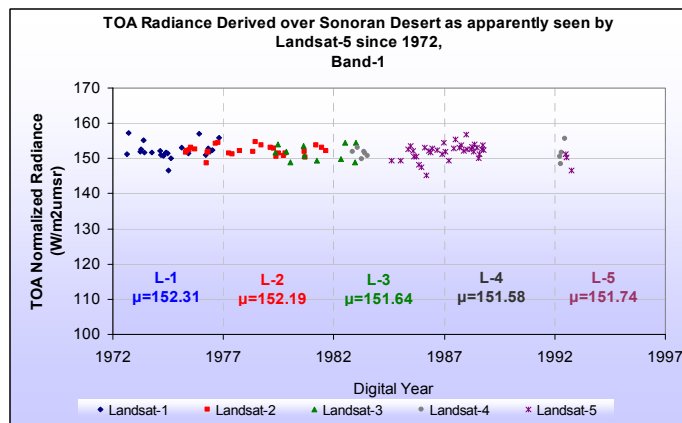
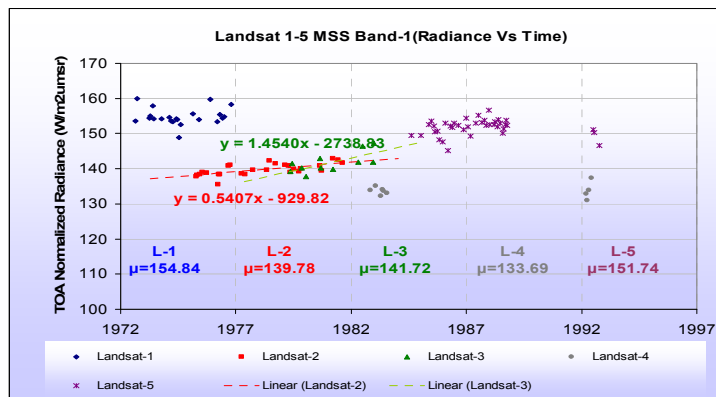
- **Band-to-Band registration typically 0.05 pixels or better in line and scan direction (excluding band 6)**
- **Switch to bumper mode disrupted ETM+ sensor alignment calibration and degraded geodetic accuracy**
  - ◆ Pre-switch : 97% scenes better than 50 meters RMSE
  - ◆ Post-switch: 65% scenes better than 50 meters RMSE
- **Relative detector-to-detector normalization, i.e., striping less than  $\pm 0.1\%$**
- **Absolute radiometric accuracy better than  $\pm 5\%$  (reflective) and 1 K (thermal)**
- **Noise stable over mission life**
- **SLC failure had no significant impact on L7 ETM+ reflective band radiometry- continues to be excellent**

# Landsat MSS Recap

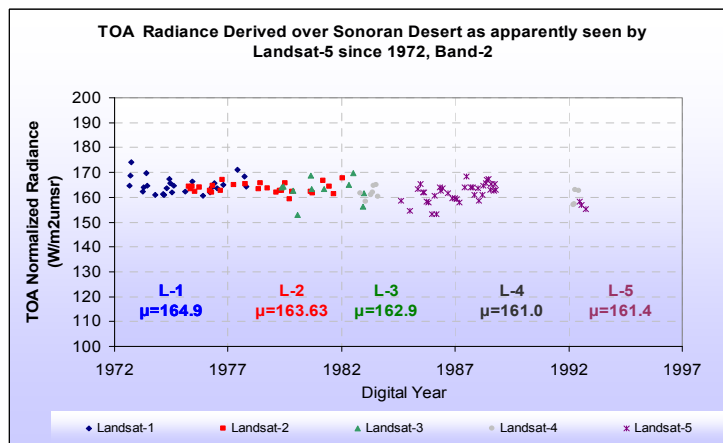
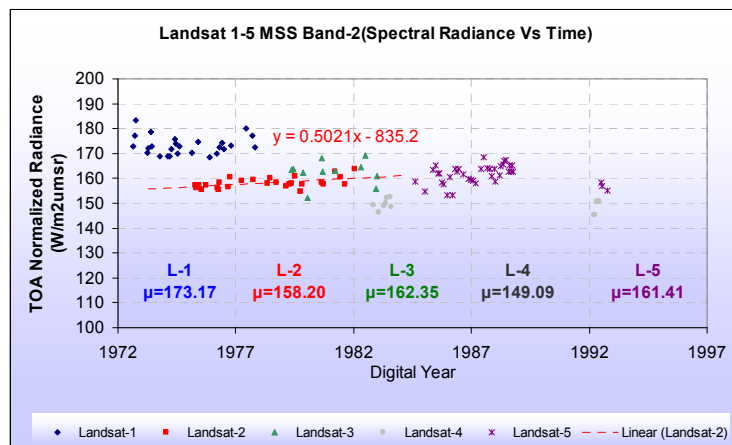
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- **MSS-X (WBVT) Landsat 1, 2, & 3** **~156,000 scenes**
  - ◆ Radiometric corrections applied
  - ◆ Archived on a scene by scene basis, band sequential format
  - ◆ Several thousand “Orphan” scenes exist
- **MSS-X (Goddard “CCT-X”) Landsat 1, 2, & 3** **~43,000 scenes**
  - ◆ Radiometric corrections applied
  - ◆ Similar physical format as MSS-X (WBVT) but with more information in header data
  - ◆ Archived on a scene by scene basis, band sequential format
- **MSS-A (archived source) Landsat 2, 3, 4, & 5** **~261,000 scenes**
  - ◆ Radiometric corrections applied
  - ◆ Systematic Geometric corrections calculated, not applied (A to P)
  - ◆ Archived on a scene-by-scene basis, band sequential format
- **MSS-P (processed source) Landsat 2 & 3** **~61,000 scenes**
  - ◆ Radiometric and geometric corrections (is a systematic product)
  - ◆ Physical format is similar to MSS-A

# MSS Radiometric Calibration Finalization



**Before  
cross-  
calibration  
applied**



**After  
cross-  
calibration  
applied**

# Summary of MSS Cross-calibration Revisited

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## Absolute Calibration Differences

	Before Calibration	After Calibration	
		(TOA Reflectance Space) ( Previous method)	(TOA Radiance Space) Updated method
Band 1	16%	2%	Less than 1%
Band 2	17%	3%	2%
Band 3	8%	3%	3%
Band 4	11%	6%	5%



# Landsat Global Archive Consolidation Data in International Archives

<u>Landsat 1-7</u>	<u>Scenes</u>	<u>Size (TB)</u>
Italy	1,545,000	520
Canada	660,000	185
Australia	600,000	125
Brazil	480,000	67
China	415,000	126
Japan (Restec)	403,000	53
Thailand	240,000	43
Argentina	195,000	67
South Africa	153,000	32
Ecuador	80,000	17*
Pakistan	34,000	7*
India	97,000*	20*
Mongolia	9,000*	2*
Saudi Arabia	69,000*	14*
Taiwan	18,000*	4*
<u>Landsat 7 only</u>		
Japan (Hiroshima)	18,000	11
Germany	23,000*	14*
Indonesia	42,000*	26*
Korea	9,000*	6*
Puerto Rico	<u>42,000*</u>	<u>26*</u>
<b>Total</b>	<b>5,132,000</b>	<b>1.3 PB</b>

Numbers are based on information that Landsat has gathered to date from International Cooperator ground receiving stations.

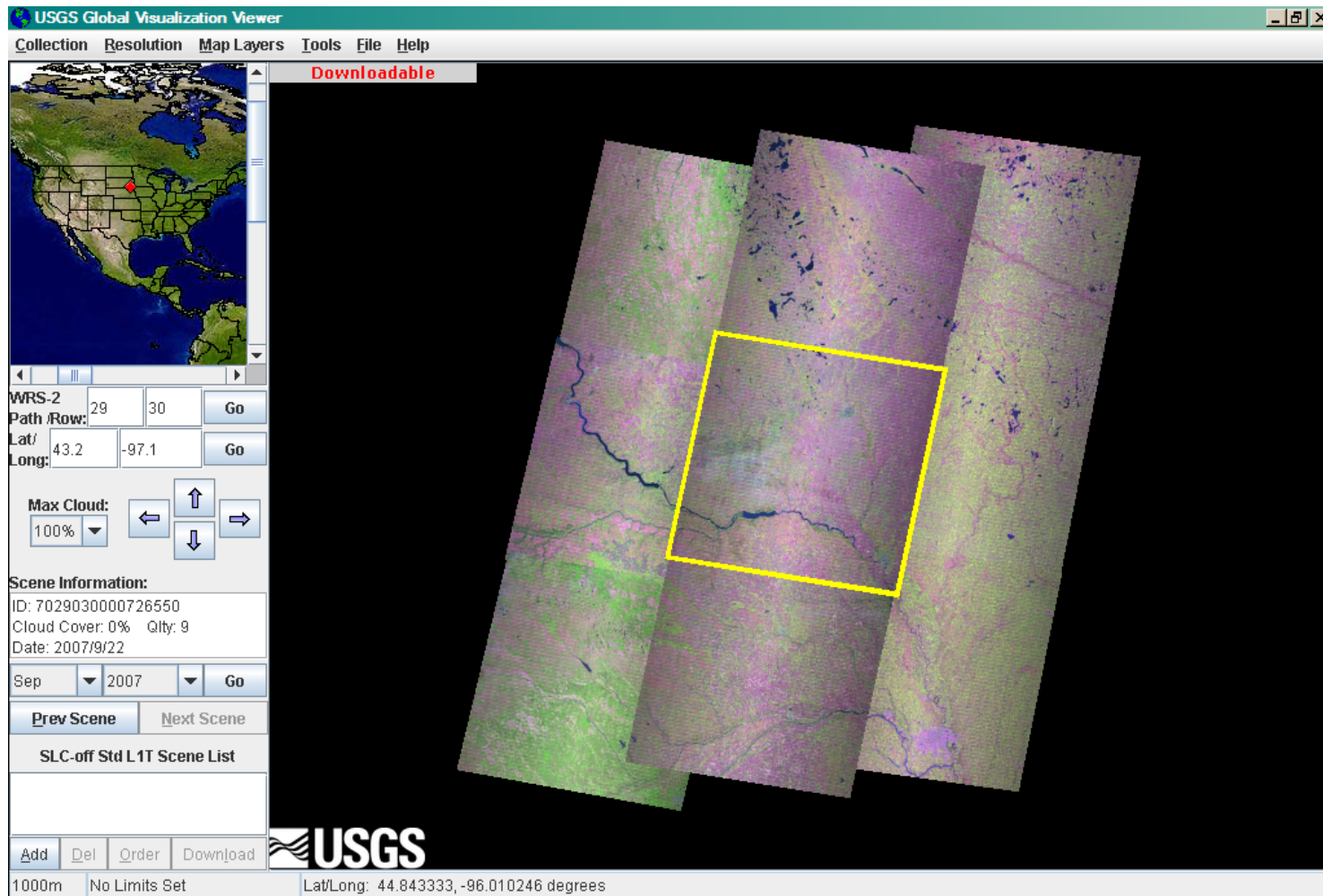
\*Numbers are estimates derived from the length of a station's active data-reception period (Scenes) and the type of sensor data it has received (Size).

# Landsat Data Distribution Concept

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- **Process and Distribute data freely to users**
  - ◆ Process new data (currently <40% cloud cover) automatically for immediate download
  - ◆ Process requests on-demand for other data in archive
- **Single Processing Parameter Recipe**
  - ◆ Pixel size: 15m/30m/60m
  - ◆ Media type: Download only
  - ◆ Product type: L1T (terrain-corrected)
  - ◆ Output format: GeoTIFF
  - ◆ Map projection: UTM
  - ◆ Orientation: North up
  - ◆ Resampling: Cubic convolution

# Web-Enabled Glovis Interface



# L0Rp To The Public

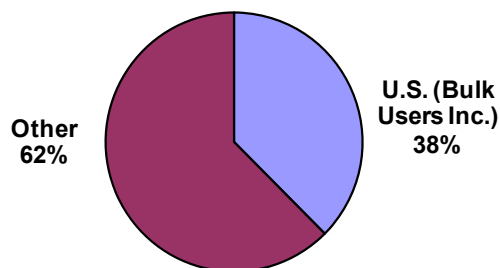
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- **Released L0Rp on-demand capability in early January**
  - ◆ All requests are handled on-demand
  - ◆ Request access through customer services or contact Rachel Headley at [rheadley@usgs.gov](mailto:rheadley@usgs.gov)
  - ◆ Once given access, users may select L0Rp scenes in the shopping cart
  - ◆ Data will be placed on the FTP server and cleaned up after a configurable number of days
    - Currently set to 10 days

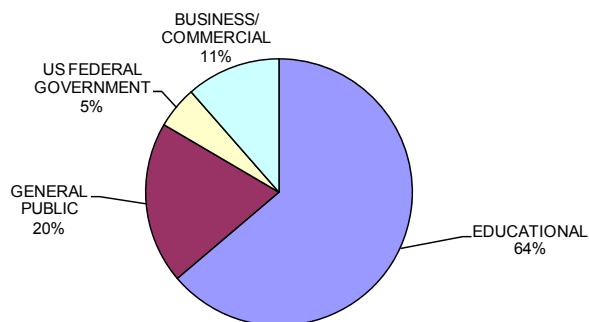


# Web-enabled Customer Demographics

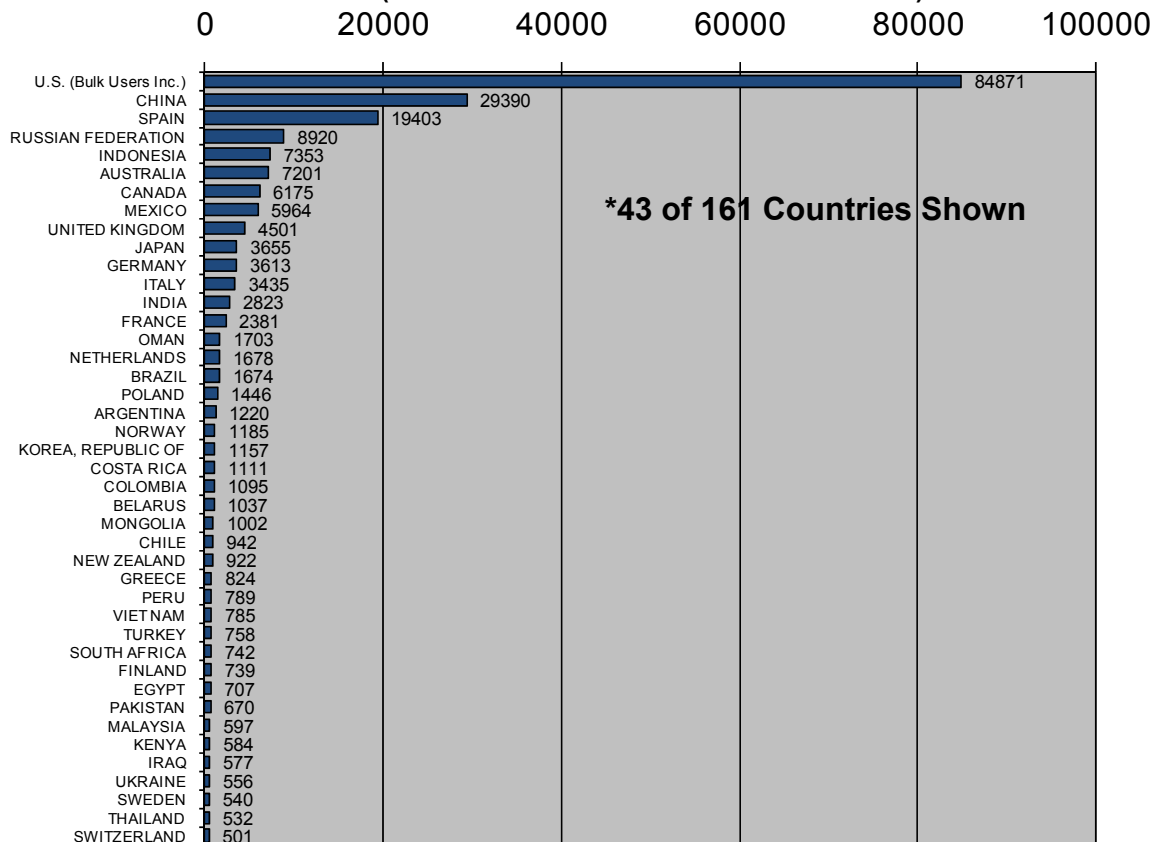
Downloads by Country



Downloads by Affiliation

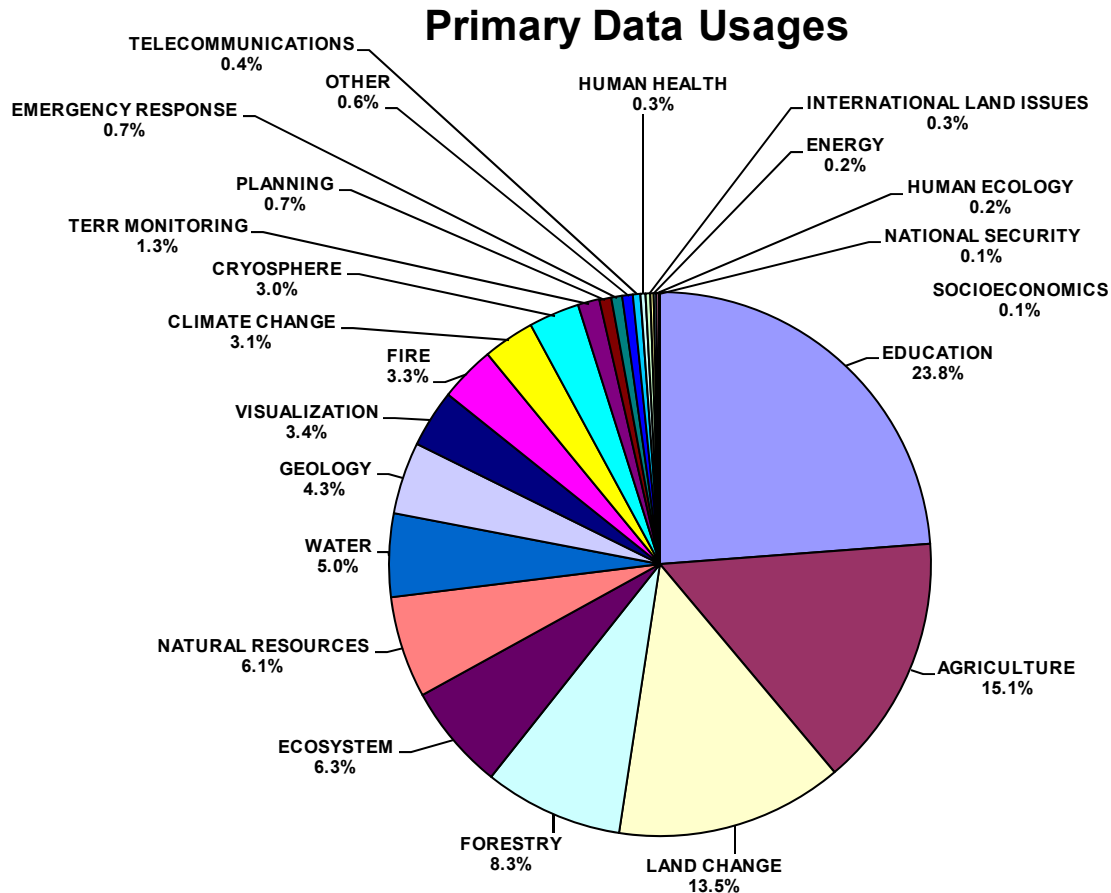


Standard L1T Downloads by Country  
(Countries with >500 Scenes Downloaded)



\* Stats 10/1/09 through 10/31/09

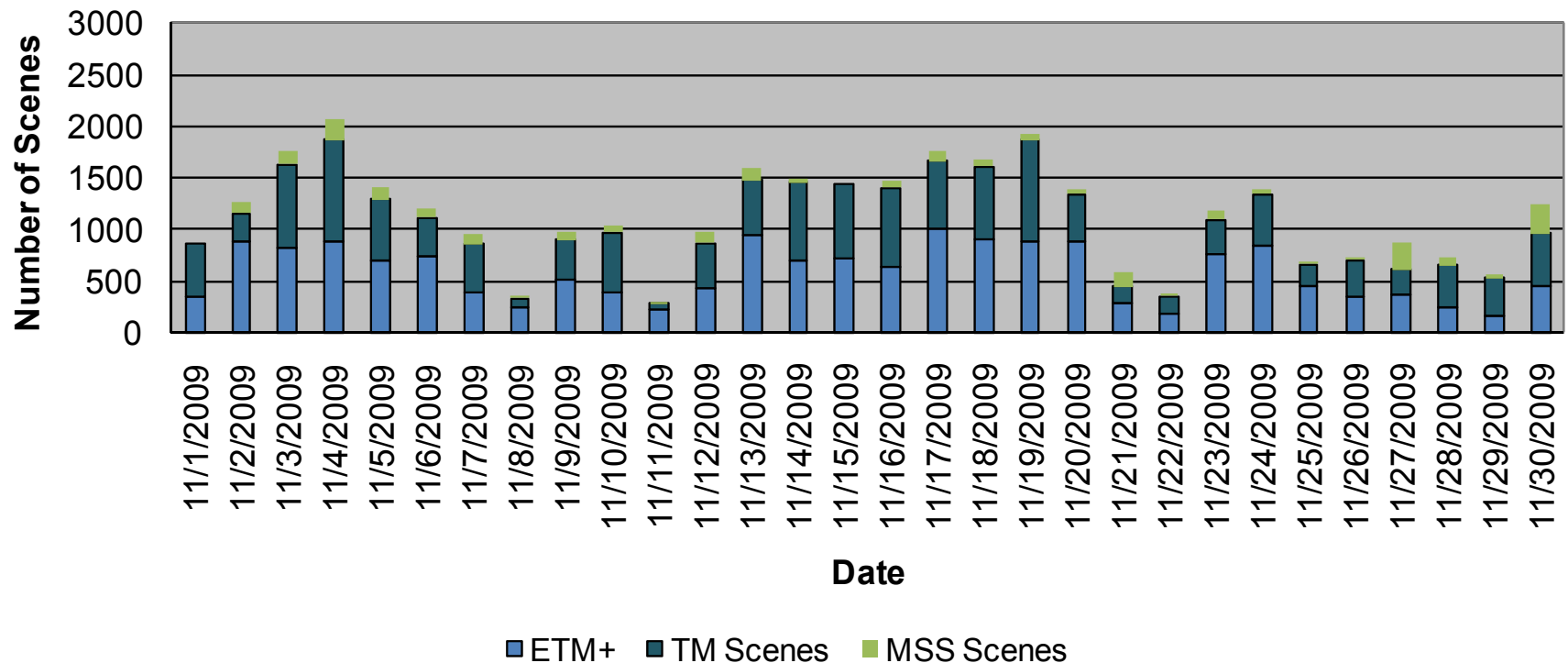
# User Reported Primary Use of Landsat (Nov 1, 2009 – Nov 30, 2009)



# Daily Processing

## Landsat Standard L1T Scenes Available on FTP Server

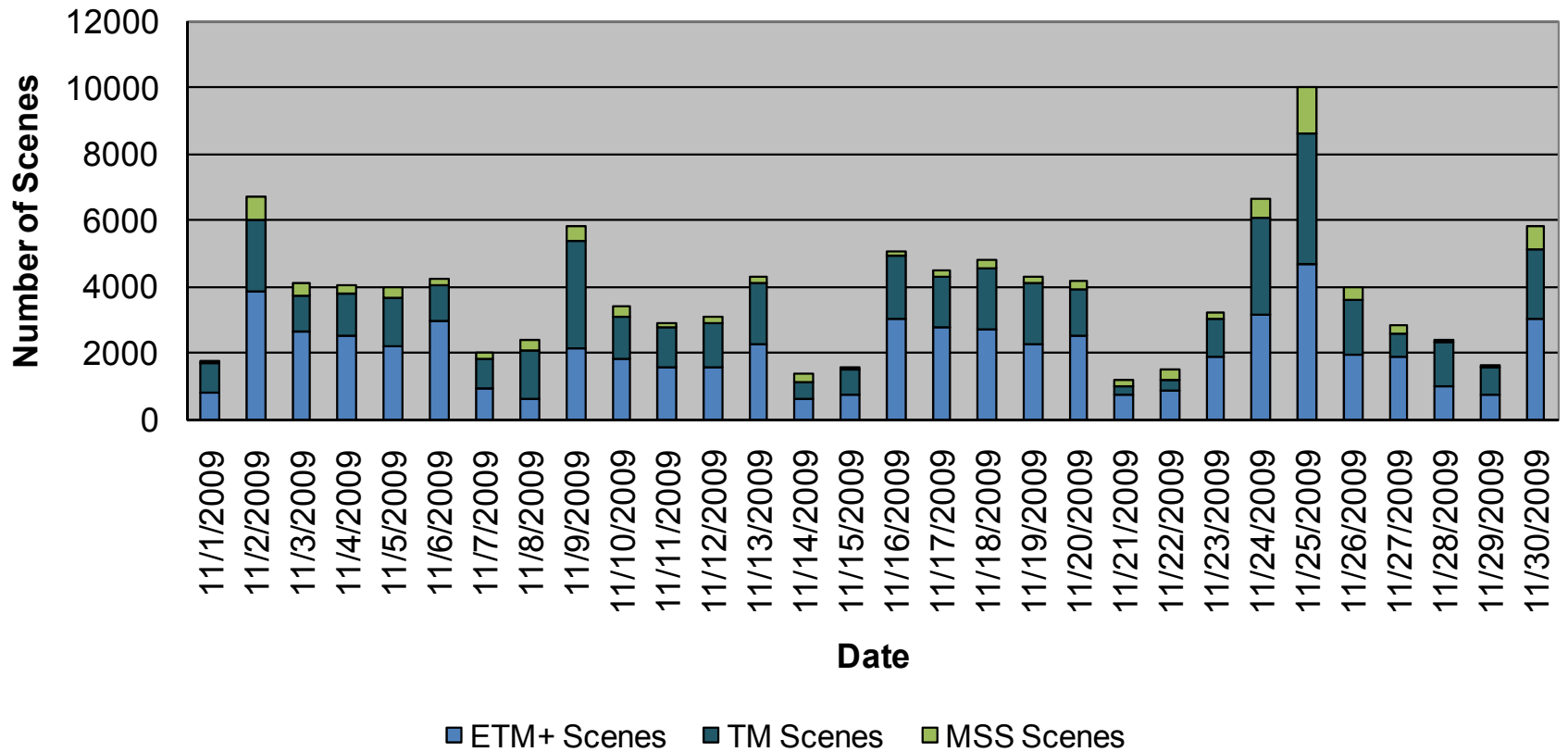
Cumulative Scenes through 11/30/2009: 344,322



# Daily Downloads

## Landsat Web-Enabled Downloads

Cumulative Scenes Downloaded 10/01/2009 through 11/30/2009: 225,836



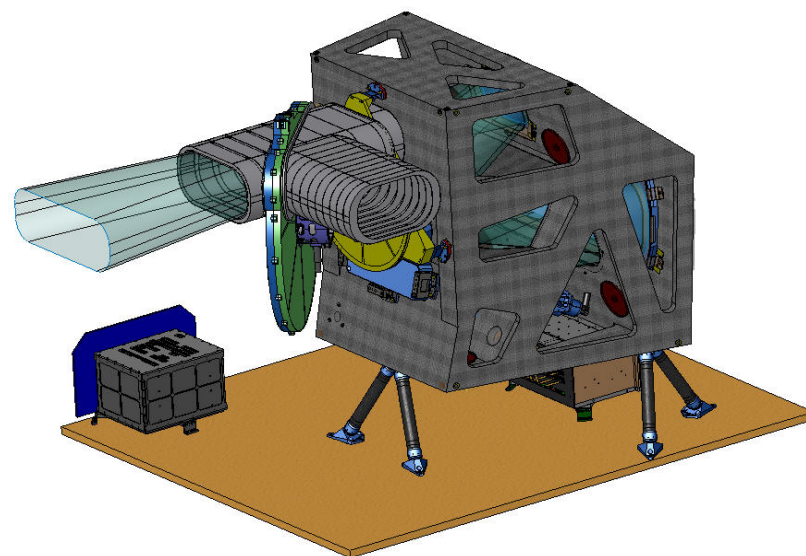


# Operational Land Imager (OLI)

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Contract awarded to Ball Aerospace Technical Corp. (BATC) July 2007  
Critical Design Review Completed Oct. 2008

- Pushbroom VIS/SWIR sensor
- Four-mirror telescope with front aperture stop
- FPA consisting of 14 sensor chip assemblies, passively cooled
- Aperture 135 mm
- F number 6.4
- 36  $\mu\text{m}$  / 18  $\mu\text{m}$  detectors (MS / Pan)



Courtesy of BATC

# Driving Performance Requirements

## ■ Radiometric

- Signal-to-noise radiometric stability (16-day, 60 sec, 5 year)
- Pixel-to-pixel uniformity
- Absolute radiometric accuracy
  - ❖ Absolute radiance – 5%, absolute reflectance – 3%

## ■ Spectral

- Spectral band edges and center wavelength tolerance
- Integrated out-of-band (OOB) response (<2%)
- Spectral uniformity (FWHM) ( $\pm 3\%$ )

## ■ Spatial

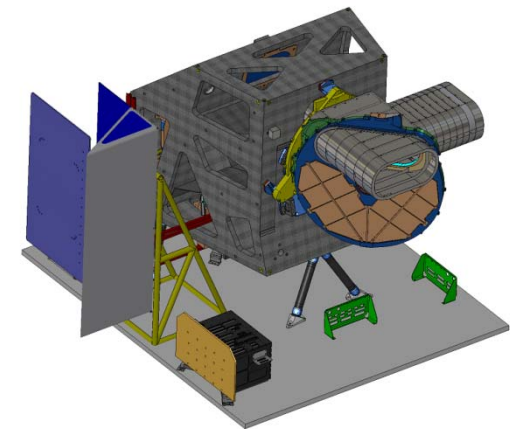
- Edge response
- Aliasing
- Light rejection and internal scattering
- Ghosting

## ■ Geometric

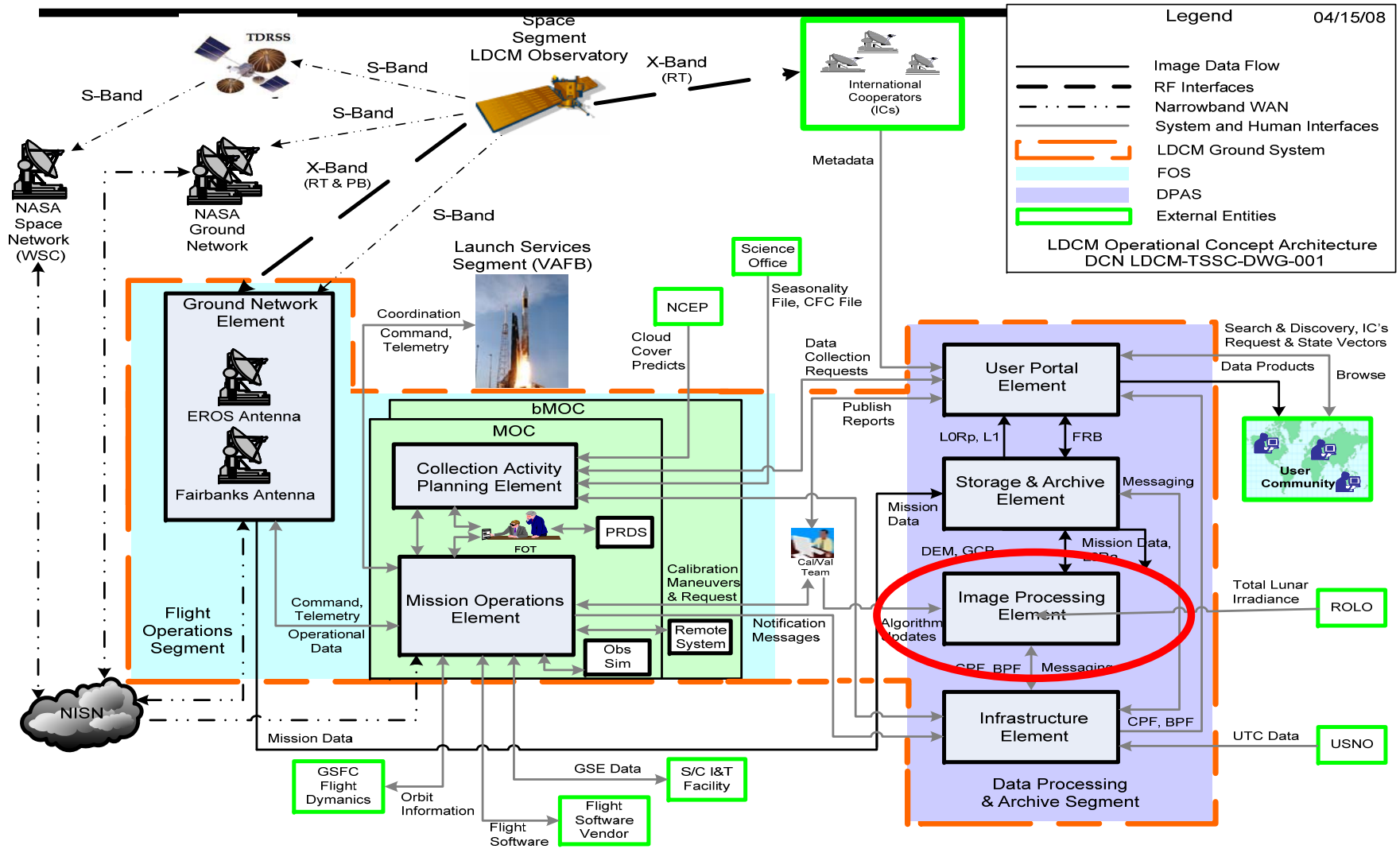
- Band-to-band co-registration (4.5 m)
- Absolute geodetic accuracy (65 m)

OLI Band and SNR Specs

#	Minimum Lower Band Edge (nm)	Maximum Upper Band Edge (nm)	SNR at L Typical	SNR at L High
1	433	453	130	290
2	450	515	130	360
3	525	600	100	390
4	630	680	90	340
5	845	885	90	460
6	1560	1660	100	540
7	2100	2300	100	510
8	500	680	80	230
9	1360	1390	50	N/A



# LDCM Ground System Overview



# Geometry Algorithms

Algorithm Name	Status	Instrument	Subsystem	Phase 3 Delivery
Ground Control Point Correlation/Mensuration		TIRS	LPGS/IAS	
Redundant Detector Row Replacement		TIRS	LPGS/IAS	
Off-Nadir Scene Framing		both	IS	
Lunar Precision		OLI	CVTK	
Ground Control Point Correlation/Mensuration	delivered	OLI	LPGS/IAS	11/30/09
Terrain Occlusion	delivered	OLI	LPGS/IAS	12/30/09
Geodetic Accuracy Assessment (L1Gs)		OLI	IAS	01/29/10
Resampling	delivered	OLI	LPGS/IAS	02/26/10
Geometric Accuracy Assessment (L1T)	delivered	OLI	IAS	03/31/10
Image Registration Accuracy Assessment		OLI	IAS	03/31/10
Band Registration Accuracy Assessment		OLI	IAS	03/31/10
Line of Sight Model Creation		OLI	LPGS/IAS	04/30/10
Band Alignment Calibration		OLI	IAS	04/30/10
Resampling		TIRS	LPGS/IAS	05/07/10
Focal Plane Alignment Calibration		OLI	IAS	05/31/10
Line of Sight Projection Ellipsoid & Terrain		OLI	LPGS/IAS	06/30/10
Line of Sight Model Creation		TIRS	LPGS/IAS	07/09/10
Line of Sight Model Correction		both	LPGS/IAS	07/30/10
Line of Sight Projection Ellipsoid & Terrain		TIRS	LPGS/IAS	08/06/10
Ancillary Data Preprocessing		both	LPGS/IAS	08/31/10
Band Registration Accuracy Assessment		TIRS	IAS	09/10/10
TIRS Band Alignment Calibration		TIRS	IAS	09/10/10
Sensor Alignment Calibration		OLI	IAS	09/30/10
TIRS Alignment Calibration		TIRS	IAS	11/05/10
MTF Lunar Characterization		OLI	CVTK	11/30/10
MTF Bridge Characterization		OLI	CVTK	11/30/10

# Radiometry Algorithms

Algorithm Name	Status	Instrument	Subsystem	Phase 3 Delivery
Temperature Conversion		TIRS	CVTK	
Cloud Cover Assessment - temporal		independent	LPGS/IAS	
Cloud Cover Assessment - Parallax		independent	LPGS/IAS	
Relative Gain Characterization (90-degree Yaw)		TIRS	CVTK	
Stray Light Characterization		TIRS	CVTK	
Contamination Characterization		TIRS	CVTK	
Contamination Correction		TIRS	CVTK	
Nonlinear Response Characterization		TIRS	CVTK	
Dropped Frame Characterization	delivered	both	LPGS/IAS	04/30/09
Cloud Cover Assessment - control	delivered	independent	LPGS/IAS	07/31/09
Cloud Cover Assessment - AT-ACCA	delivered	independent	LPGS/IAS	07/31/09
Cloud Cover Assessment - See5	delivered	independent	LPGS/IAS	07/31/09
Non-uniformity Characterization	delivered	both	IAS	09/01/09
Temperature Sensitivity Correction	delivered	both	LPGS/IAS	09/01/09
Impulse Noise Characterization	delivered	both	LPGS/IAS	09/01/09
L1R SCA Stitching	delivered	both	IAS	09/29/09
Gain Application	delivered	both	LPGS/IAS	09/30/09
Histogram Statistics Characterization	delivered	both	LPGS/IAS	09/30/09
Detector Response Characterization (Solar Diffuser)	delivered	OLI	IAS	10/30/09
Saturated Pixel Characterization	delivered	both	LPGS/IAS	11/06/09
SCA Overlap Statistics Characterization	delivered	both	LPGS/IAS	11/06/09
Reflectance Conversion	delivered	OLI	LPGS/IAS	11/30/09
60s Radiometric Stability Characterization	review	OLI	IAS	01/11/10
Saturated Pixel Replacement	review	both	LPGS/IAS	01/15/10
Radiance Rescaling	review	both	LPGS/IAS	01/15/10
SCA Discontinuity Correction	review	both	LPGS/IAS	01/22/10



# Radiometry Algorithms (cont'd)

Algorithm Name	Status	Instrument	Subsystem	Phase 3 Delivery
Detector Response Characterization (Lamp)	review	OLI	IAS	01/29/10
Inoperable Detectors Fill		both	LPGS/IAS	01/29/10
Striping Characterization		both	LPGS/IAS	01/29/10
Residual Striping Correction	review	both	LPGS/IAS	01/29/10
Bias Removal		OLI	LPGS/IAS	02/26/10
Response Linearization		OLI	LPGS/IAS	02/26/10
Bias Determination		OLI	LPGS/IAS	02/26/10
Bias Model Calibration		OLI	IS	02/26/10
Lunar Irradiance Characterization		OLI	CVTK	03/31/10
Bias Removal		TIRS	LPGS/IAS	05/07/10
Response Linearization		TIRS	LPGS/IAS	05/07/10
White Noise Characterization		both	CVTK	05/31/10
Detector Operability Characterization		both	CVTK	05/31/10
SNR Characterization		OLI	CVTK	05/31/10
Contamination Characterization		OLI	CVTK	05/31/10
Dark Response Determination		TIRS	IAS	06/11/10
Radiometric Response Determination		TIRS	IAS	06/11/10
NEdL Characterization		TIRS	CVTK	06/30/10
Nonlinear Response Characterization		OLI	CVTK	06/30/10
Radiometric Stability Characterization		TIRS	CVTK	06/30/10
Stray Light Characterization		OLI	CVTK	07/31/10
Gain Trending		both	CVTK	08/31/10
Temperature Sensitivity Characterization		both	CVTK	08/31/10
Relative Gain Characterization (90-degree Yaw)		OLI	CVTK	08/31/10
Performance Trending		both	CVTK	08/31/10
Coherent Noise Characterization		both	CVTK	10/29/10
Relative Gain Characterization (Histogram Method)		both	CVTK	10/29/10
1/f Noise Characterization		both	CVTK	11/26/10
Contamination Correction		OLI	CVTK	11/26/10

# Landsat Science Team

[http://landsat.usgs.gov/science LST Team Meetings.php](http://landsat.usgs.gov/science_LST_Team_Meetings.php)

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- **USGS is co-chairing and funding the Landsat Science Team**
  - ◆ 1<sup>st</sup> Science Team meeting: January 9-11, 2007
  - ◆ 2<sup>nd</sup> Science Team meeting: June 12-14, 2007
  - ◆ 3<sup>rd</sup> Science Team meeting: January 8-10, 2008
  - ◆ 4<sup>th</sup> Science Team meeting: July 17-17, 2008
  - ◆ 5<sup>th</sup> Science Team meeting: Jan 6-8, 2009
  - ◆ 6<sup>th</sup> Science Team meeting: Jan 19-21, 2010
- **The Science Team is funded to conduct research and provide feedback to the LDCM in several areas**
  - ◆ Applied research in natural resource monitoring and algorithm development
  - ◆ Participation in ground system requirements reviews
  - ◆ Definition of product specifications
  - ◆ Development of LTAP-8
  - ◆ Instrument Engineering
  - ◆ Communications and Outreach & Policy recommendations

# LDCM Full-Resolution Browse

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- **Browse images will be created for quick and efficient image selection and for visual interpretation. The following three criteria are critical to meet user needs for browse images:**
  - ◆ Provide a browse that is geo-registered and GIS-ready
  - ◆ Provide full spatial resolution browse for local area evaluation
  - ◆ Provide small browse definition for quick delivery, particularly for large areas, over the Internet, and for creation of page-size graphics
- **There may be up to five browse files associated with each scene:**
  - ◆ Reflective OLI full resolution JPEG image: 3 band, 8-bits per band
  - ◆ Reflective OLI reduced resolution JPEG image: a reduced resolution version of the reflective full resolution browse
  - ◆ Thermal TIRS full resolution JPEG image: 1 band, 8-bit grayscale
  - ◆ Thermal TIRS reduced resolution JPEG image: a reduced resolution version of the thermal full resolution browse
  - ◆ Quality band PNG: a color mapped version of the quality band – future activity for Landsat 1-7

# Full-Resolution Reflective Browse

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- **Band combinations – “Green”**
  - ◆ OLI: 6,5,4
  - ◆ ETM+ & TM: 5,4,3
  - ◆ MSS: 2,4,1
- **Data values**
  - ◆ Top of Atmosphere Reflectance
  - ◆ 0 - 0.8 stretched to 0 - 255
- **Image format**
  - ◆ 3-band RGB JPEG
  - ◆ Georeference information in World & GDAL XML files
  - ◆ JPEG and georeference files zipped for download
- **File size is approximately 5 MB**
- **Pixel size is retained**
- **<http://picasaweb.google.com/soapnut>**

# Full-Resolution Thermal Browse

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- **Band combinations**

- ◆ TIRS
- ◆ TM: Band 6
- ◆ ETM+: Band 61 (low gain)
- ◆ MSS: None

- **Data values**

- ◆ Top of Atmosphere Brightness Temperature
- ◆ -40 °C to 50 °C stretched to 0 – 255 or 2% clip

- **Image format**

- ◆ Gray-scale JPEG
- ◆ Georeference information in World & GDAL XML file
- ◆ JPEG and georeference files zipped for download

- **File size is approximately 2 MB**

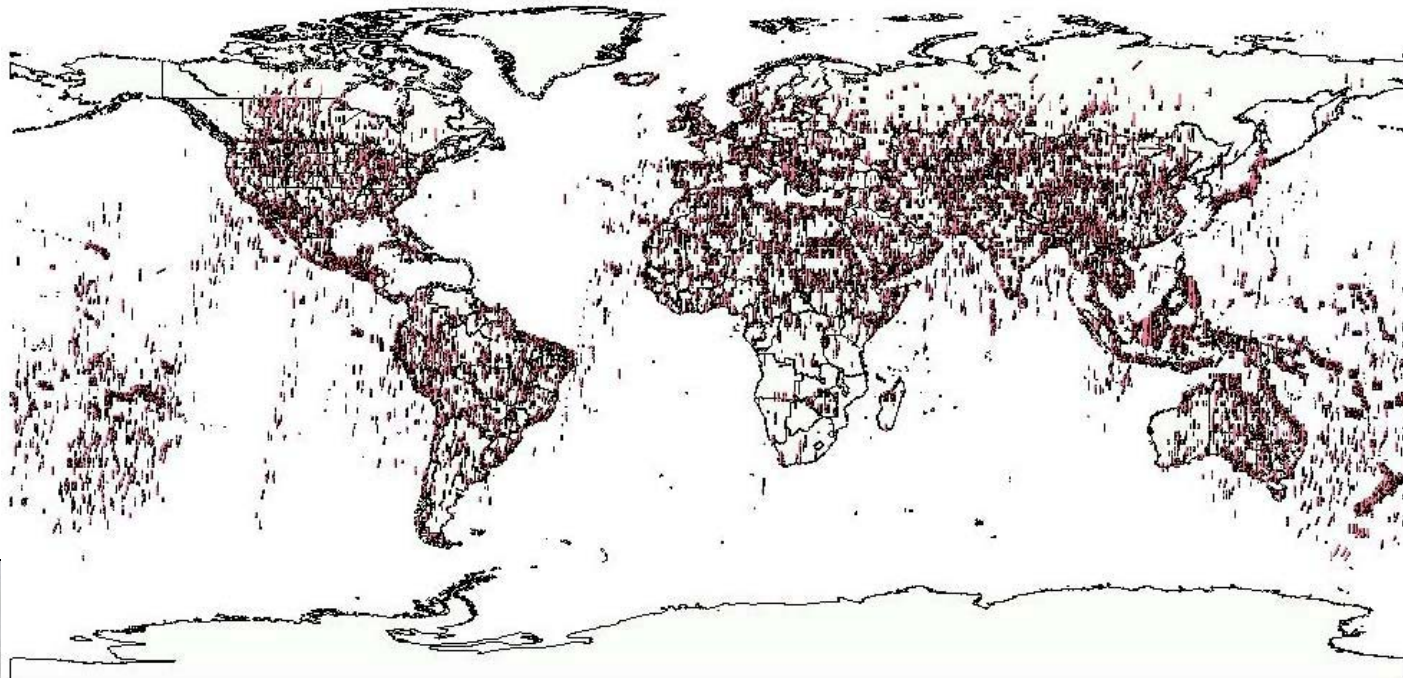
- **Pixel size is retained**



# GeoEye OrbView-3 Data Purge

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- **GeoEye contacted the USGS about their intention to purge OrbView-3 archive, per NOAA license**
  - ◆ The satellite was launched June 26, 2003 and was considered inoperable in March 2007 The collection is comprised of 530,424 images
  - ◆ Over 80% of the collection is made up of pan (1 m); ms is 4-m, 4 band
  - ◆ Approximately 50% of total has 10% or less cloud cover
  - ◆ Includes open data policy



# SPOT Update

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- **USGS EROS currently collecting conterminous US SPOT data for 2010 (one year agreement; hopefully will be extended)**
- **Data will be available to all US Federal Government agencies and collaborators through Earth Explorer**
- **Data are not terrain corrected or radiometrically calibrated**
- **Southern US scenes currently being collected; as season progresses, collections will “move” northward (collections based on growing season)**

# SPOT: North America Data Buy

- USGS, in partnership with NASA and the USDA, have contracted to receive satellite data over North America. The USGS recently awarded a contract to SPOT Image Corporation for moderate-resolution optical satellite data. This data buy includes all collections of SPOT 4 and SPOT 5 data for the next 12 months over the conterminous U.S. and parts of Canada and Mexico. Data will be made available at no cost to U.S. Federal Civil Agencies and U.S. State and Local Government users, per the licensing arrangements. SPOT data will be directly downlinked to the USGS at the EROS Center following the installation of a SPOT ground processing capability.

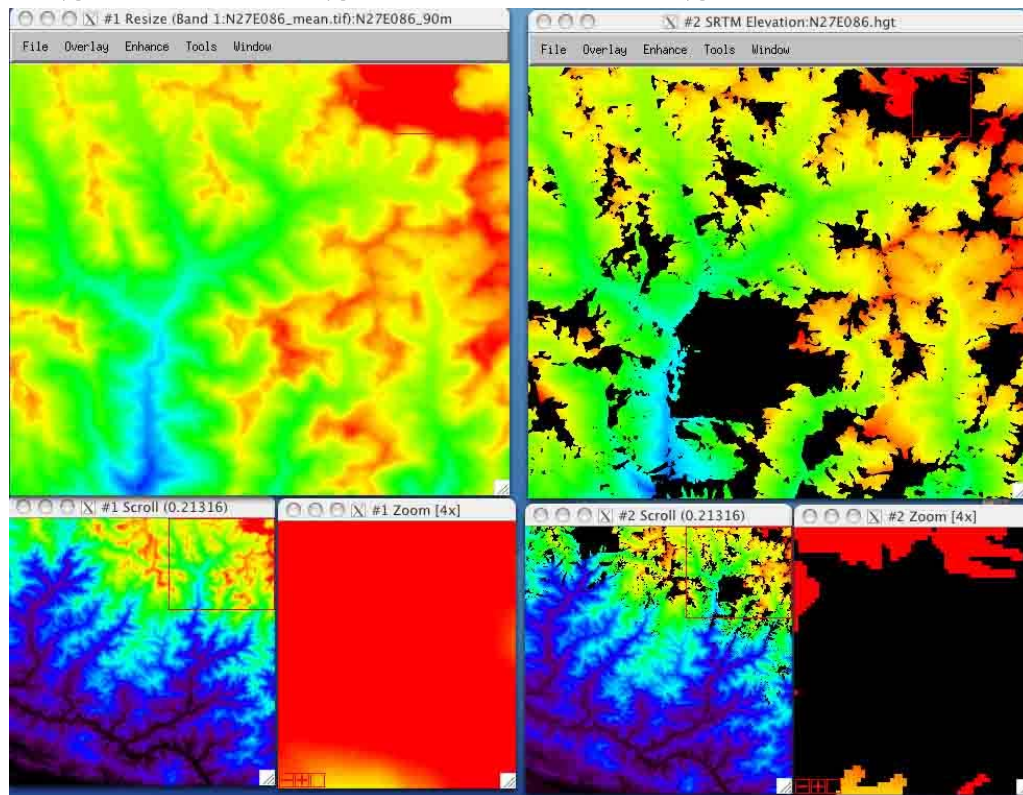
Date	Number of Spot 5 Scenes	Number of Spot 4 Scenes
12/28/2009	20	
12/30/2009	20	
12/31/2009	10	
1/4/2010	31	6
1/5/2010	83	
1/6/2010	68	
1/7/2010	39	
1/8/2010	35	
1/11/2010	33	
1/12/2010	45	
1/13/2010	30	
Total	414	6





# ASTER Global DEM Project

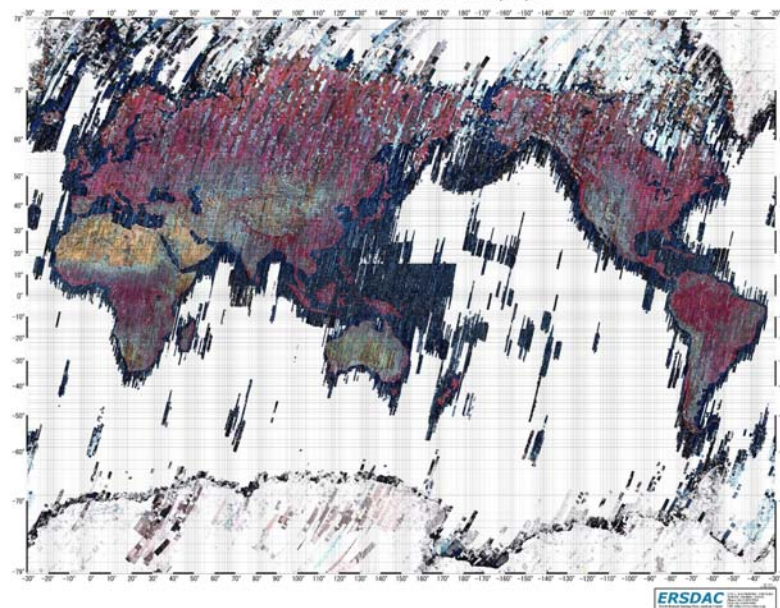
## Stacked ASTER



- 203 scenes used
- No holes for ASTER DEM
- Many large holes for SRTM

## SRTM

Best Scenes Observed by ASTER (as of Sep. 2007)  
Total Number of L1A Scenes is About 1,072,171



- 22,895 1° x 1° tiles
- 83° N to 83° S
- 10 m Zrms
- May 2009 release

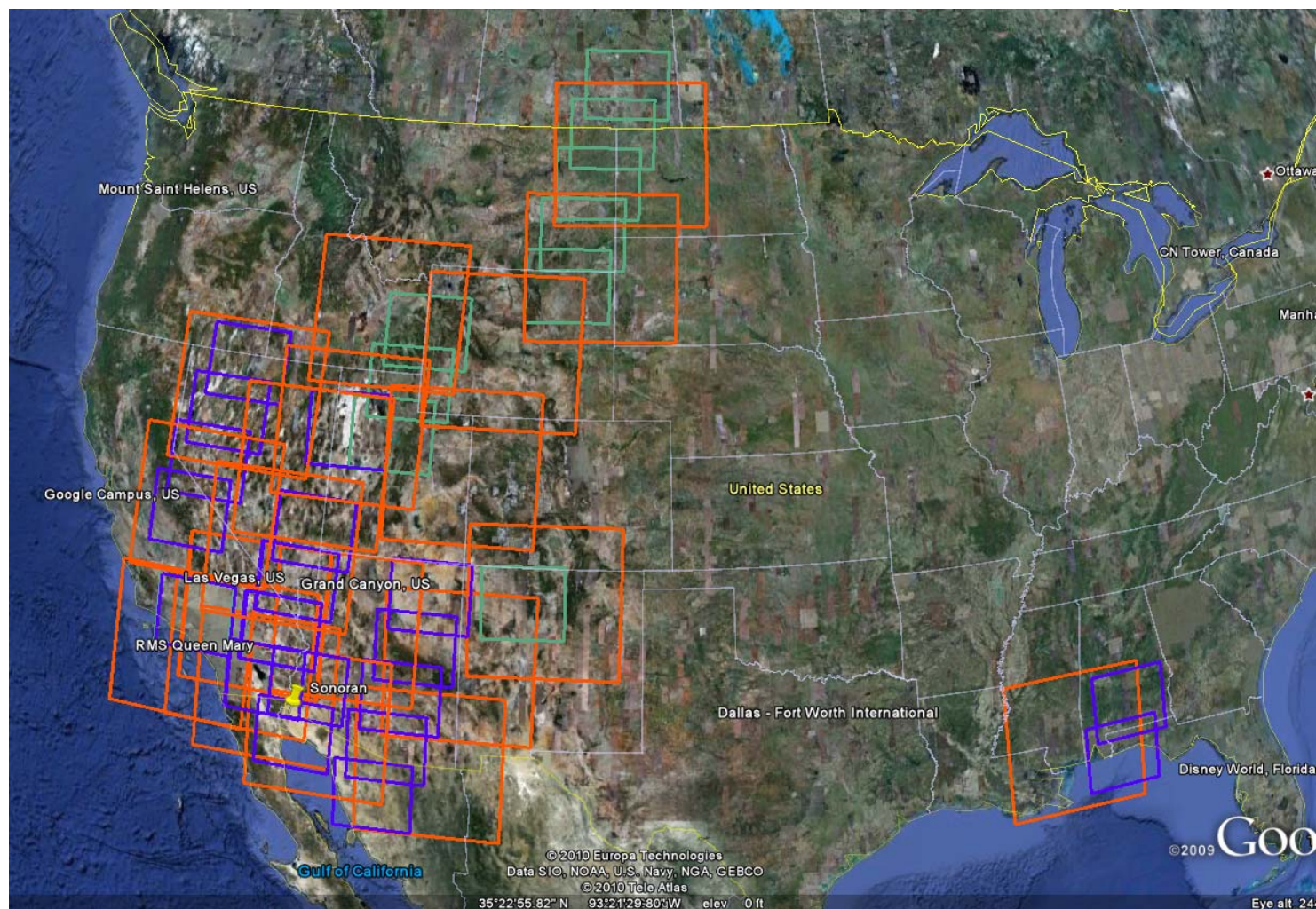
# NASA LCLUC Program Support

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- **NASA LCLUC Program supported the funding to characterize non-US Landsat-like sensors in terms of their radiometry, geometry, and other specifics as compared to Landsat, including cross-calibration between the sensors**
- **These projects will facilitate the use of the non-US sensor data for deriving LCLUC in lieu of Landsat observations if one or both Landsats become unavailable during the next couple of years, i.e. before the next Landsat is launched**

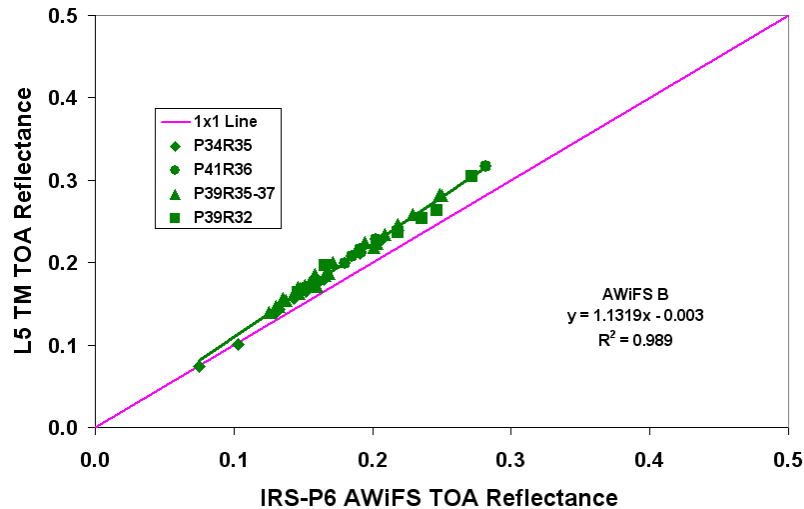


# L5 TM, L7 ETM+ & P6 AWiFS Image Pairs

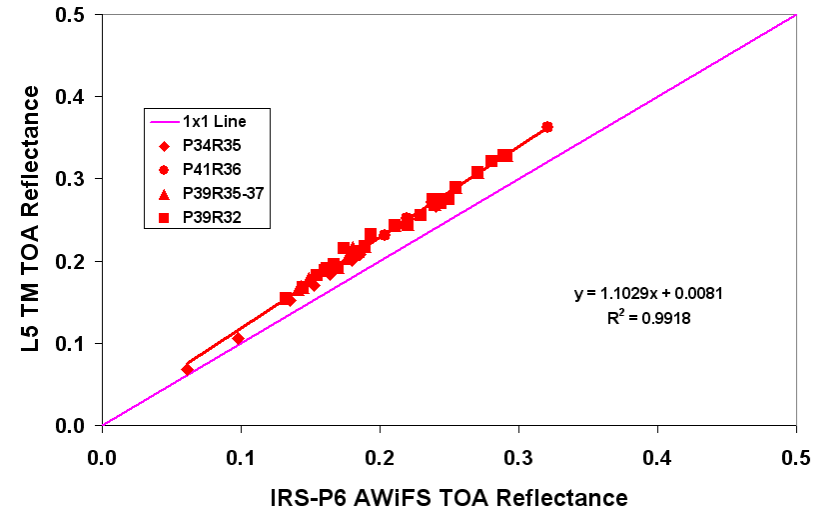


# Cross-comparison of AWiFS & TM

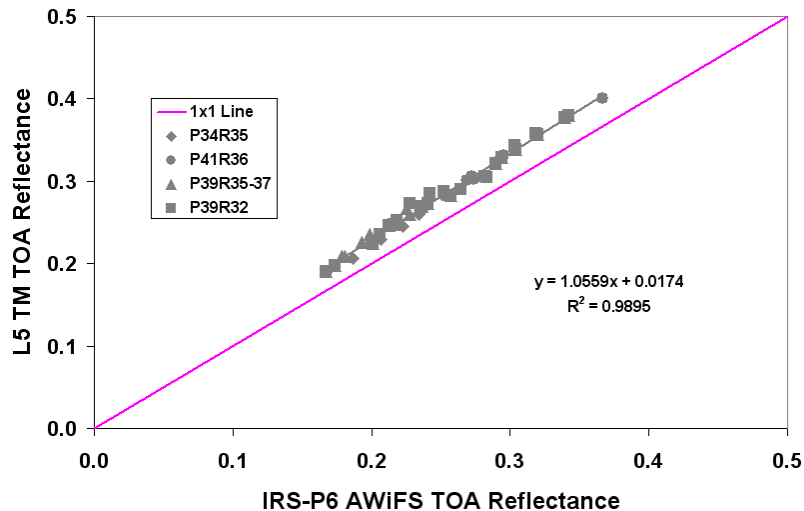
L5 TM & IRS-P6 AWiFS TOA Reflectance, Band 2



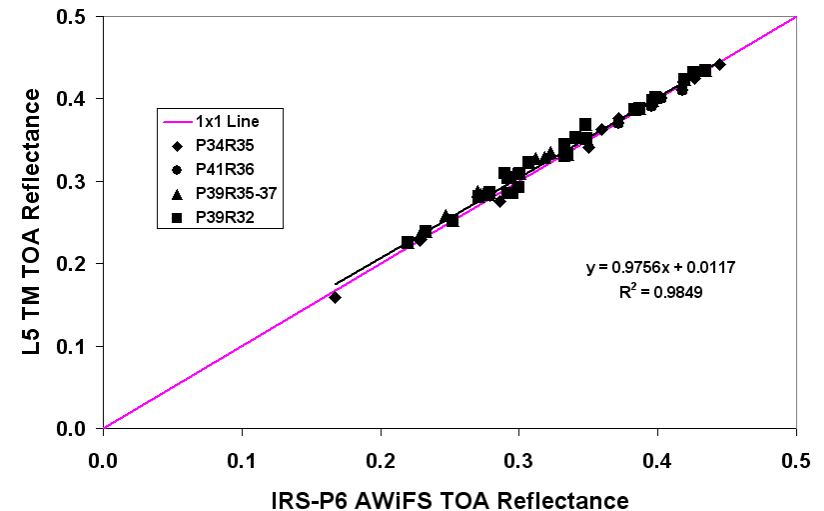
L5 TM & IRS-P6 AWiFS TOA Reflectance, Band 3



L5 TM & IRS-P6 AWiFS TOA Reflectance, Band 4

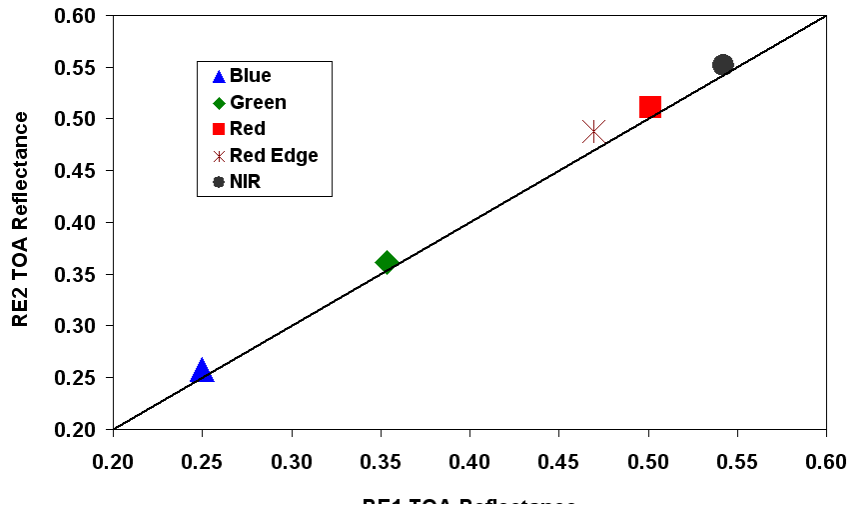


L5 TM & IRS-P6 AWiFS TOA Reflectance, Band 5

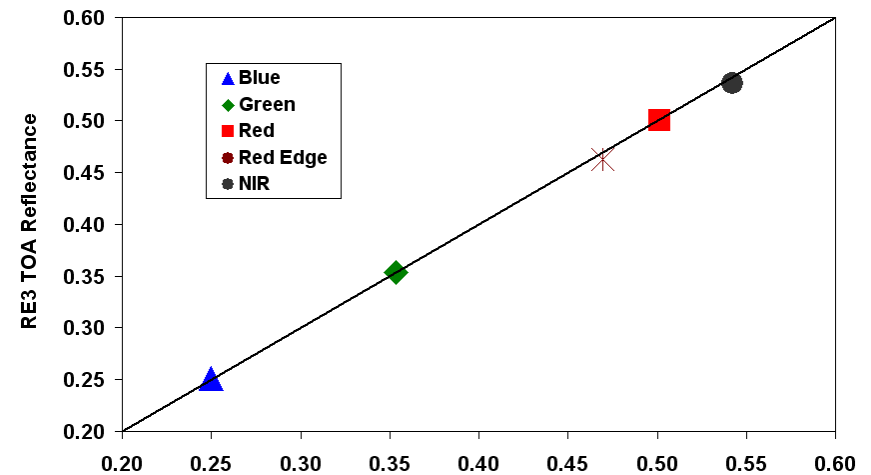


# Cross-comparison of RapidEye

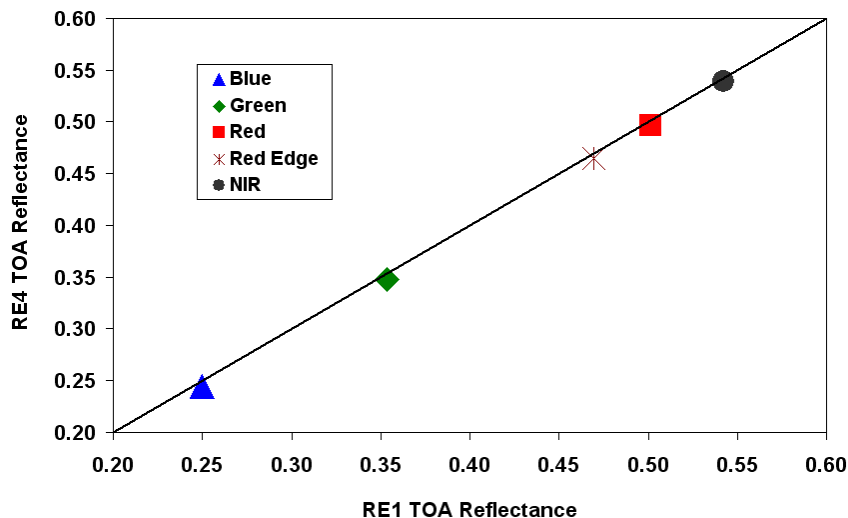
TOA Reflectance comparison of RE1 versus RE2



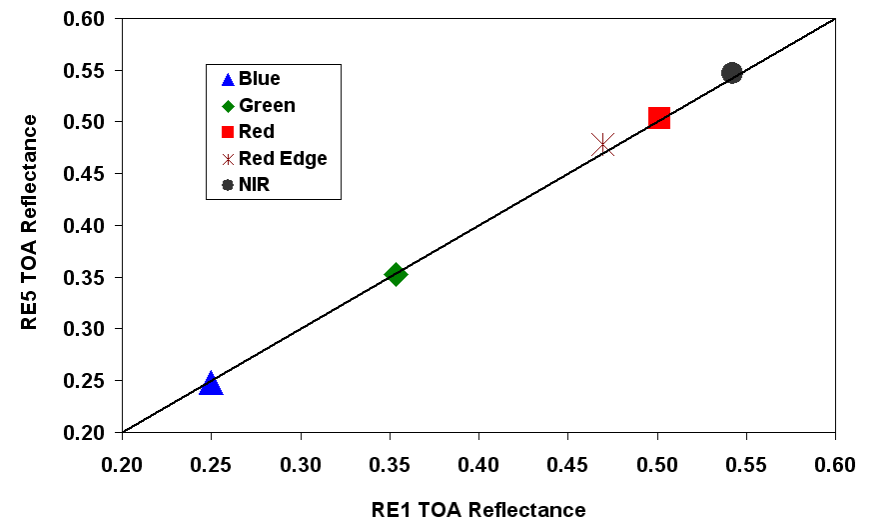
TOA Reflectance comparison of RE1 versus RE3



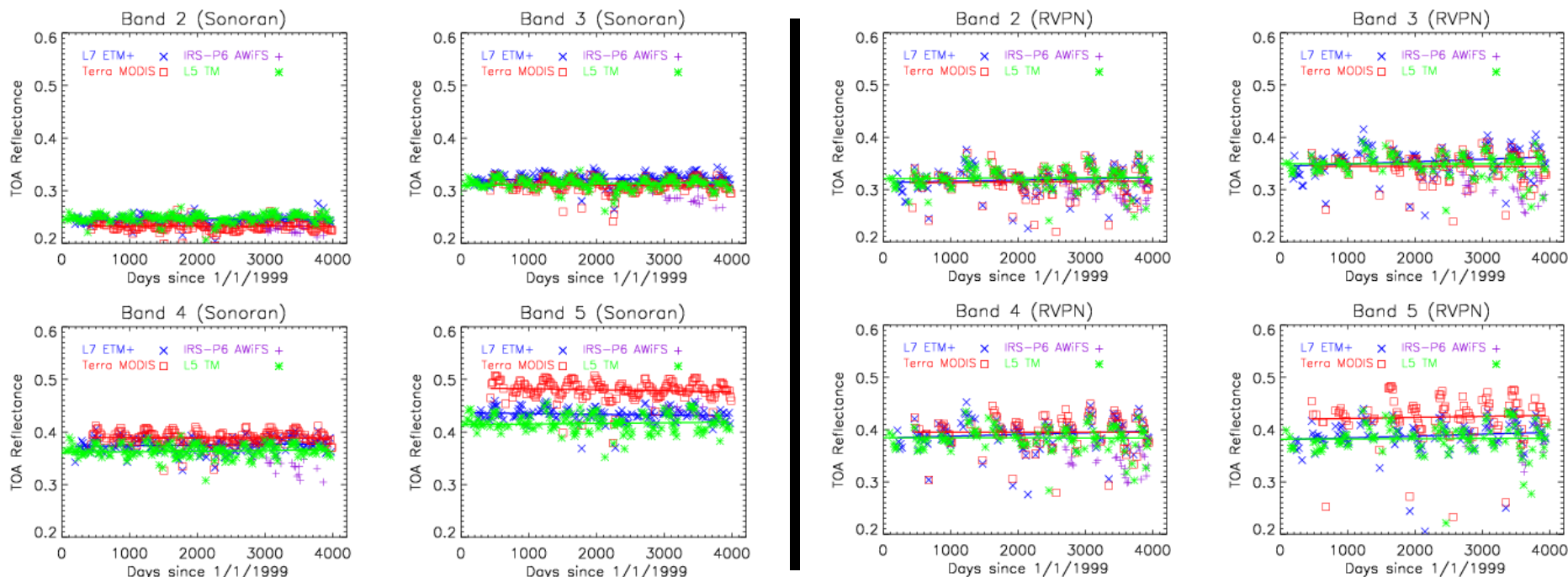
TOA Reflectance comparison of RE1 versus RE4



TOA Reflectance comparison of RE1 versus RE5



# Long-term TOA Reflectance Trending (Sonoran & Railroad Valley Test Sites)

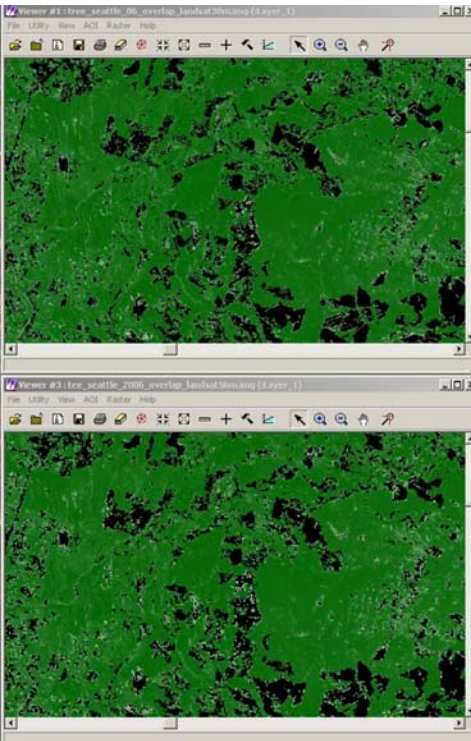


- **Linear equations are fitted to the long-term TOA reflectance trends**
  - ◆ Slope values are very small: prove the long term stability of sensors
  - ◆ There are constant offsets: caused by a combination of the spectral signature of the ground target, atmospheric composition and the RSR characteristics
- **The annual oscillation were caused by BRDF effect**

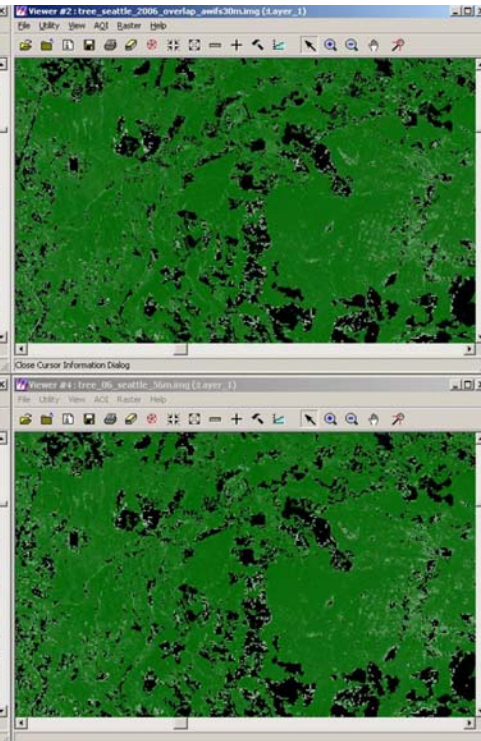


# Assessment of AWiFS data for NLCD

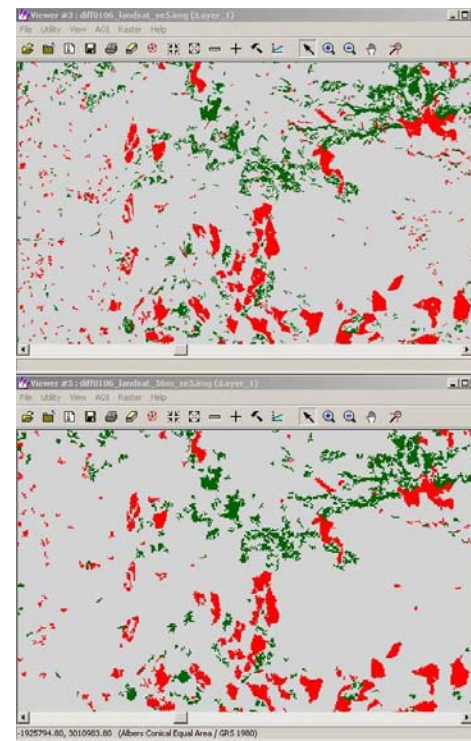
Landsat 30 m



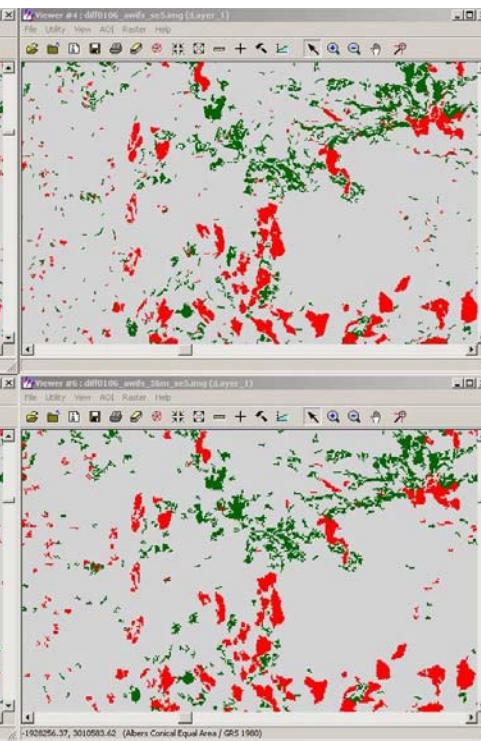
AWiFS 30 m



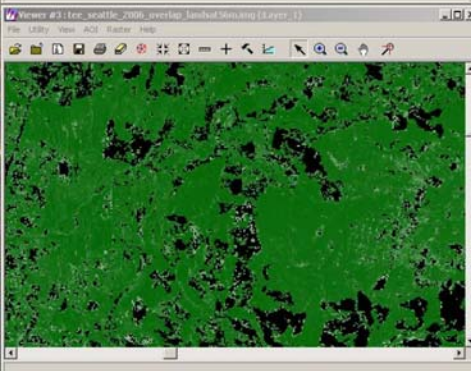
Change – Landsat 30 m



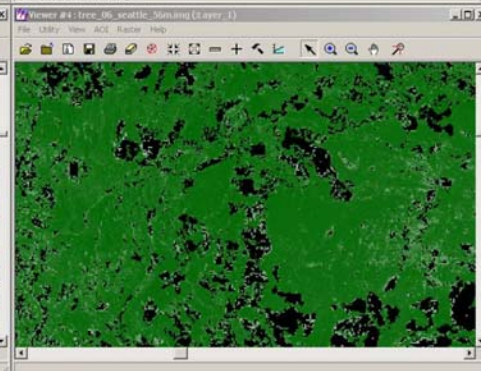
Change - AWiFS 30 m



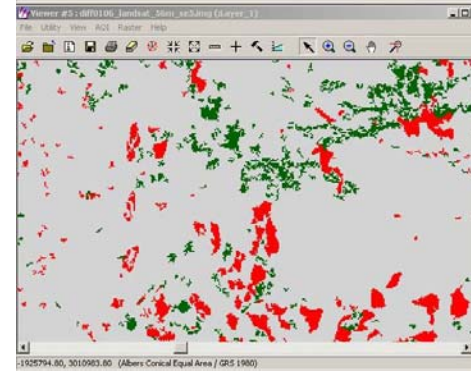
Landsat 56 m



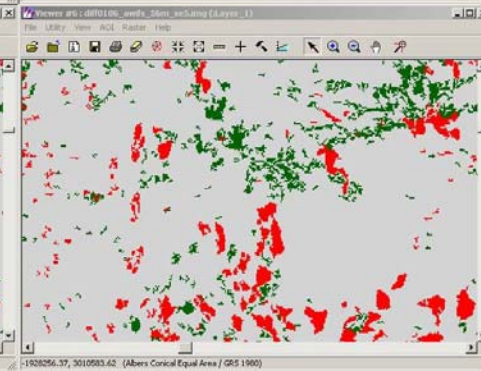
AWiFS 56 m



Change - Landsat 56 m



Change - AWiFS 56 m

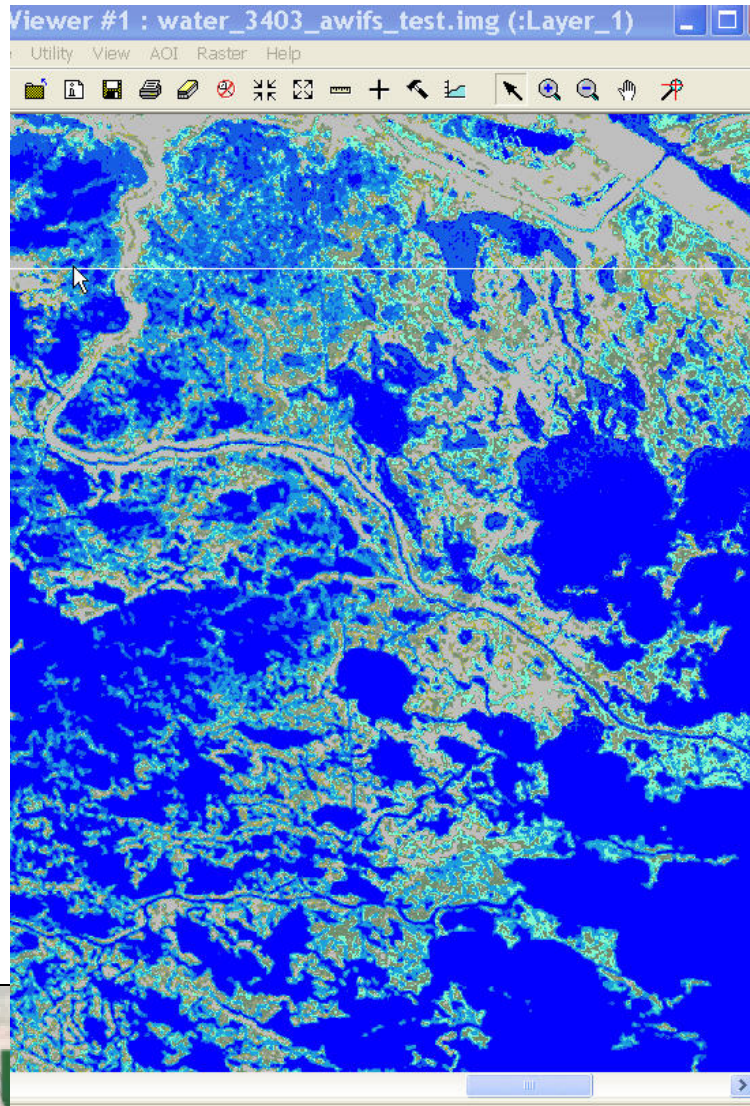


## 2006 Tree Canopy Changes in Seattle

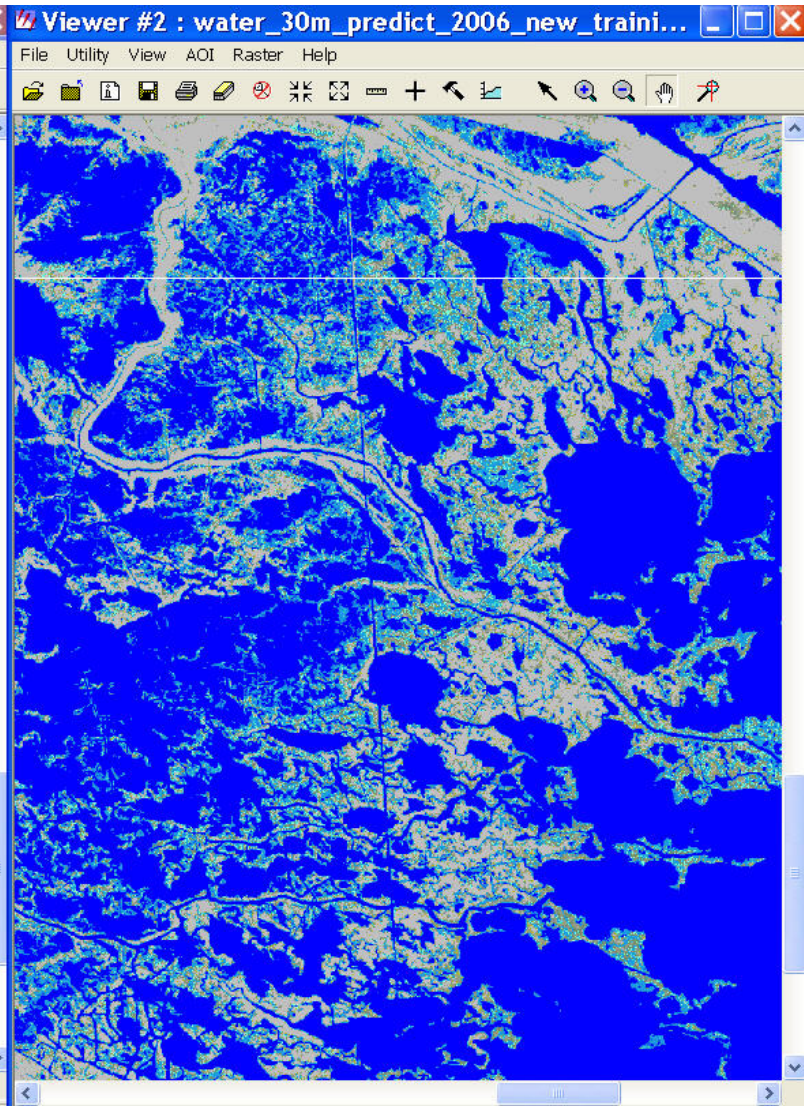


# NLCD Wetland Mapping and Monitoring

% water Sep. 27, 2006 using AWiFS



% water Sep. 26, 2006 using Landsat

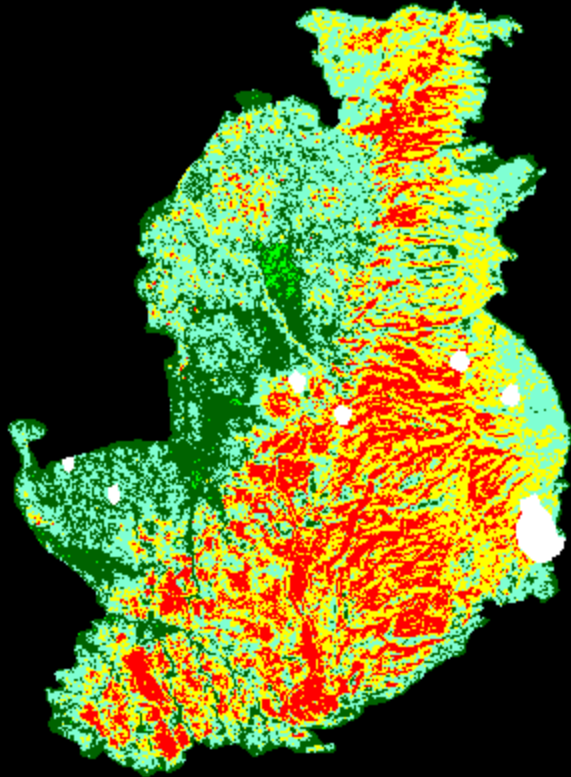




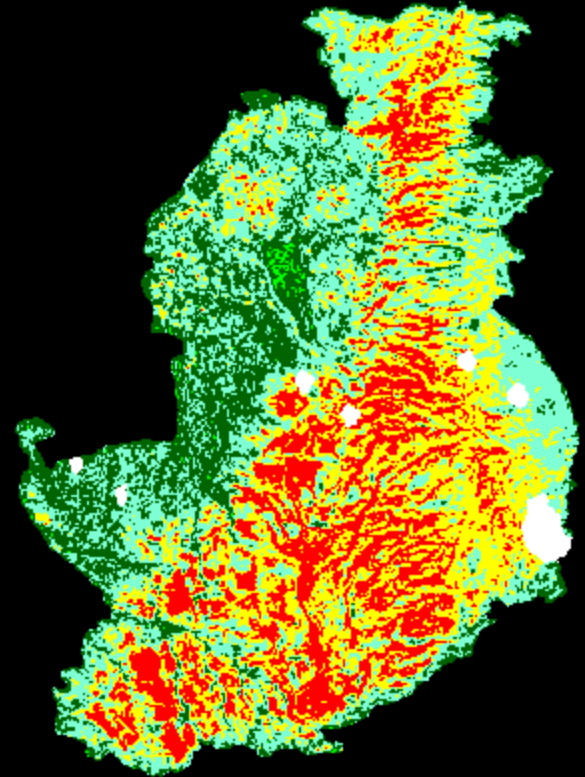
# Assessment of AWiFS data for MTBS

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**Burn Severity Maps**  
**Arizona Warm Fire: July 06, 2006**



**Official L5 TM MTBS dNBR**



**AWiFS dNBR**

# USGS EROS Find Data

USGS/EROS Find Data - Windows Internet Explorer

http://eros.usgs.gov/#/Find\_Data

File Edit View Favorites Tools Help

Internet Explorer can... The USGS Remote Se... USGS/EROS Find D... x My Yahoo!

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**Earth Resources Observation and Science (EROS) Center**

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**Products & Data Available**

- Aerial Photography
- Satellite Imagery
- Elevation
- Land Cover
- Digitized Maps
- Image Gallery Collections
- FAQs

**Data Discovery Tools**

- EarthExplorer
- New EarthExplorer
- Glovis
- The Seamless Server
- NASA LP DAAC
- USGS Geographic Data Download
- USGS Web Mapping Portal

Washington, D.C.

Accessibility FOIA Privacy Policies and Notices

[U.S. Department of the Interior](#) [U.S. Geological Survey](#)

URL: [http://eros.usgs.gov/#/Find\\_Data](http://eros.usgs.gov/#/Find_Data)

Page Contact Information: [custserv@usgs.gov](mailto:custserv@usgs.gov)

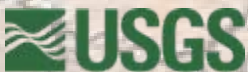
Page Last Modified: Thursday, April 16, 2009 at 00:48:45

USA.gov TAKE PRIDE IN AMERICA

Local intranet 100%

Start Mail - Inbox - IBM L... Desktop WebEx Meeting M... Microsoft PowerPol... USGS/EROS Fin...

9:16 AM



# Earth Explorer Data Portal at USGS EROS

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- [Products & Data Available](#)
- [Aerial Photography](#)
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- [New EarthExplorer](#)
- [Glovis](#)
- [The Seamless Server](#)
- [NASA LP DAAC](#)
- [USGS Geographic Data Download](#)
- [USGS Web Mapping Portal](#)

# Earth Explorer Cal/Val Data

<http://edcsns17.cr.usgs.gov/EarthExplorer/>

EarthExplorer - Windows Internet Explorer

http://edcsns17.cr.usgs.gov/EarthExplorer/

File Edit View Favorites Tools Help

Internet Explorer can... The USGS Remote Se... EarthExplorer x My Yahoo!

USGS science for a changing world


EarthExplorer


Home Login Register Shopping Basket Help

There are 3 messages. (Updated: 2/22/2010)

The U.S. Geological Survey is dedicated to providing extensive data to the global science community. However, certain data sets require additional procedures to gain access to them. For example, some commercial satellite scenes of U.S. sites are licensed only for U.S. users. Please log in to find what additional data sets may be available.


### 1. Select your dataset (s)

Click on  next to the category name to show a list of datasets.

 Icon means selected data within the Data Sets can be downloaded at no charge.

- Aerial Photography
- AVHRR
- Cal/Val Reference Sites
- Commercial
- Declassified Data
- Digital Elevation ([Related Links](#))
- Digital Line Graphs ([Related Links](#))
- Digital Maps ([Related Links](#))
- EO-1
- Forest Carbon Sites
- Global Land Survey
- Landsat Archive ([Related Links](#))
- Landsat Legacy
- Landsat MRLC
- Radar

**Selected Datasets**

 None Selected

Display Tooltips ☒

### 2. Enter your search criteria

Address/Place name  **Search** **Reset**

Search: [\(US/World Feature Search\)](#)

From (mm/dd/yyyy):  To (mm/dd/yyyy):


☐ Search these months only.

Lat/Long Grid

Dec DMS

1000 mi

1000 km



Map Satellite Terrain

☒ Show Labels

Help Hide Map Clear My Area Selection Add Map to Selection

The up to date Google map is not for purchase or for download; it is to be used as a guide for reference and search purposes only.

**Area Selected**

Degree/Minute/Second ☒ Decimal ☐

1. Latitude:  °  '  " North Longitude:  °  '  " West

**Number of Results**

Find the first  records. [Help](#)

(Note: Results will contain this number of records for each individual data set selected.)

### 3. Search >>>

49

# USGS Recommendations

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- **Coordinate and provide world-wide Cal/Val sites**
  - ◆ Coordinate and plan vicarious calibration field campaigns
  - ◆ Maintain a fully accessible Cal/Val portal to provide
  - ◆ instrument characteristics of current & future systems,
  - ◆ seamless access of Cal/Val site data for users
  - ◆ database of in-situ data, documentation of best practices
  - ◆ Info regarding co-incident imagery
- **Work with others to enhance and implement QA4EO processes**
- **Work with other agencies to characterize and cross-calibrate sensors using QA4EO processes and document processes**
  - ◆ Support methods to fill data gaps in Global Land Dataset
- **Encourage Cal/Val support for LSI activities**
- **Update CEOS WGCV web pages with membership information and technical links (being worked)**
- **Make sure that on orbit and operational instruments maintain a calibration characterization processing capability**