USGS Report to the 24th CEOS/WGCV Plenary

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John Dwyer, Gyanesh Chander

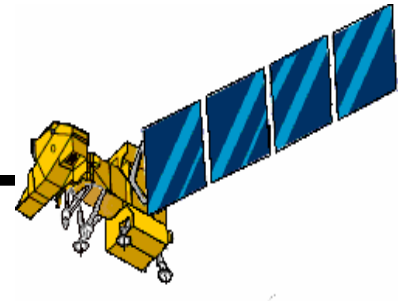
SAIC/U.S. Geological Survey, National Center for EROS

Sioux Falls, SD

Outline

- **Landsat-5/7 Status**
  - L5 TM – Improved data calibration
  - L7 ETM+ SLC-Off Product Development Status
- **Landsat Mission Data Gap Studies**
- **EO-1 ALI Update**
- **LDCM Update**
  - Prototype Studies
  - Science Team
- **Land Process Distributed Active Archive Center**
  - ASTER Status
  - MODIS Direct Broadcast
- **Commercial Providers and Cal/Val**

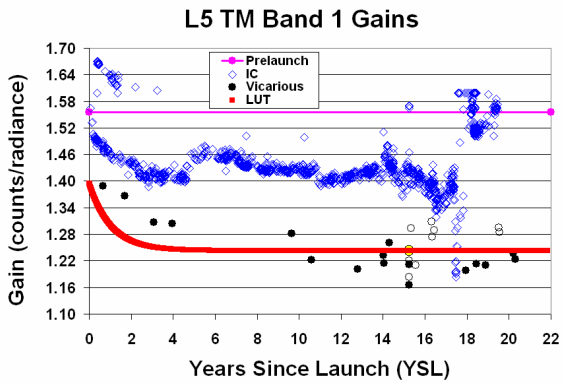
Landsat-5/7 Mission Status

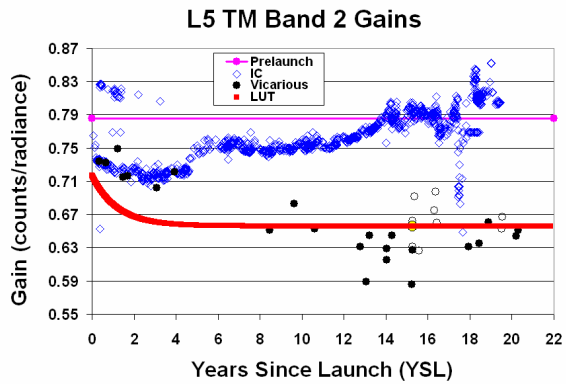


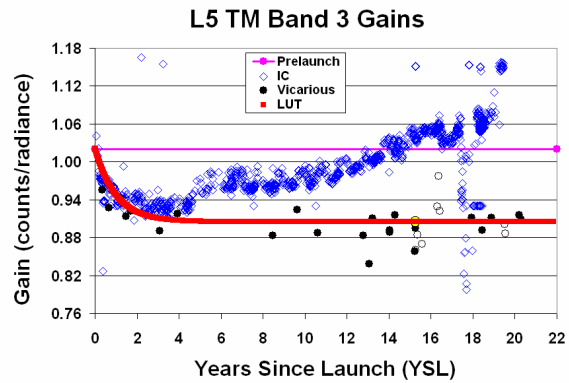
- **Landsat 7**
  - Scan Line Corrector (SLC) malfunction (May 31, 2003)
    - The SLC anomaly has not impacted the radiometric or geometric performance for existing pixels
    - New capability to improve the SLC-off data products
  - On May 5, 2004, Gyro #3 was powered off due to anomalous gyro telemetry
  - Estimated end of mission: January 2011 based on remaining fuel and assuming 9:30AM MLT crossing minimum criteria

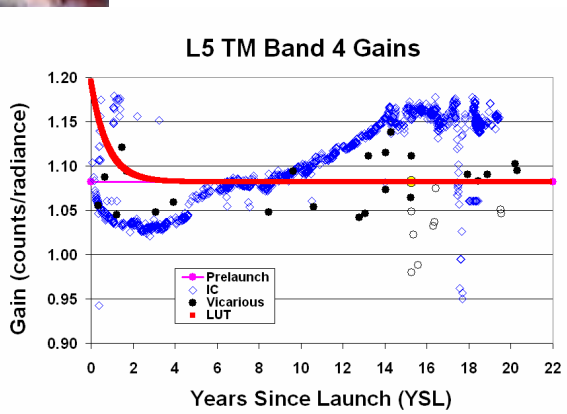
- **Landsat 5**
  - **Switch to Bumper Mode operations in May, 2002**
  - Expansion of International Ground Station (IGS) network
  - Estimated end of mission: December 2009 based on remaining fuel and assuming 9:30AM MLT crossing minimum criteria
  - New capability to improve the data calibration
    - Effective May 5, 2003, L5 TM data processed and distributed by the USGS/EOS is radiometrically calibrated using a new procedure and revised calibration parameters
    - Definitive Ephemeris (DE) generated from available satellite telemetry are now used to generate products. DE improves overall geolocation accuracy and reduces outliers

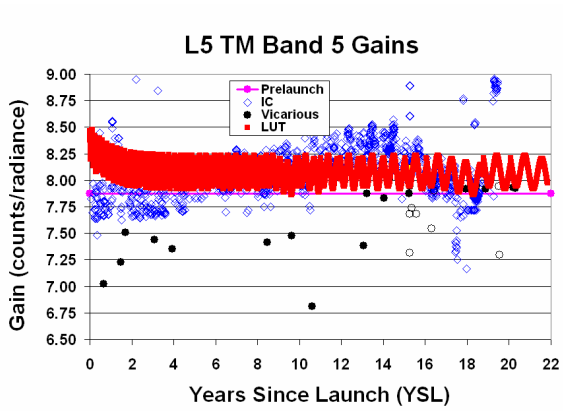
Comparison of L5 TM Radiometric Calibration Methods

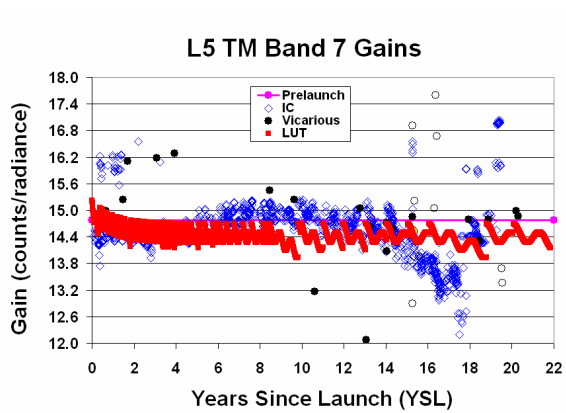












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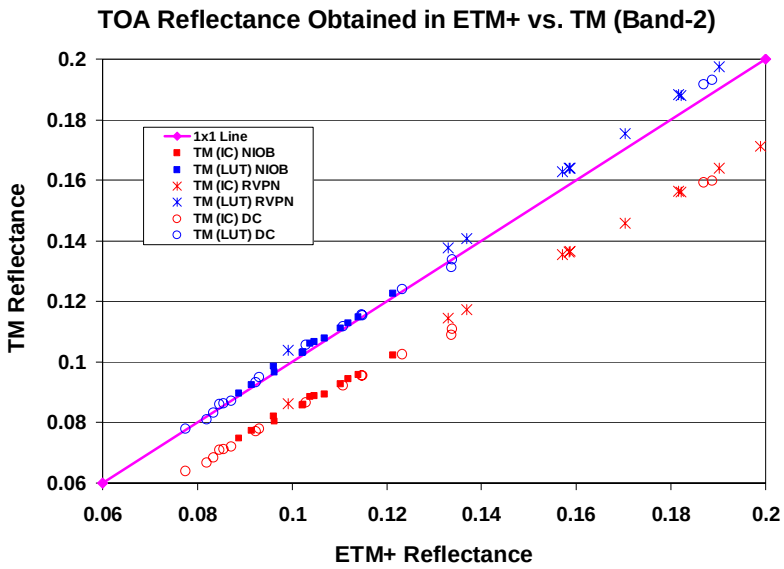
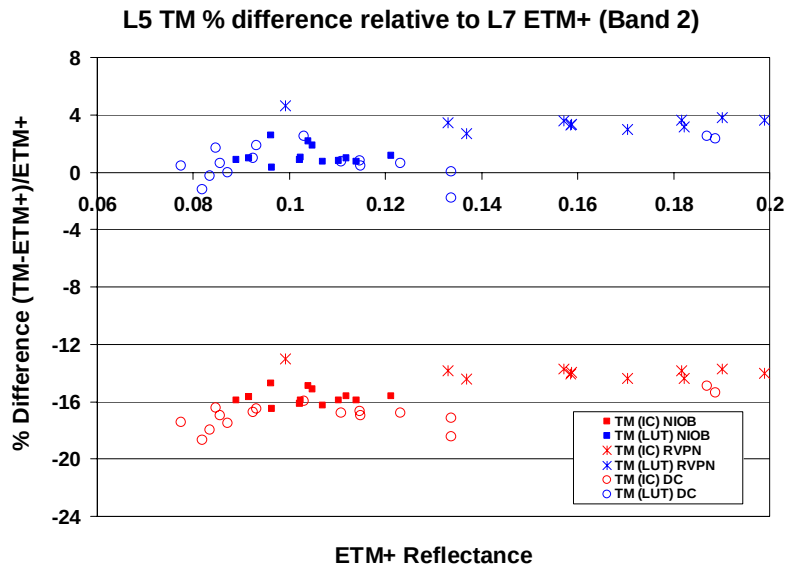
Improvement in absolute calibration accuracy of L5 TM with L7 ETM+ data





- Each data point on these plots represents an ensemble average of all pixels in a defined region for a given day and spectral band
- The plots relate reflectances extracted from L5 TM L1R data to corresponding reflectances obtained from L7 ETM+ data
- The one-to-one line points out the idealized perfect agreement between the reflectances obtained from both sensors for a particular band
- The average percent difference in reflectance measurements obtained from the L5 TM relative to ETM+ in **band-2 is reduced from about 15.6% (IC) to 1.8% (LUT)**

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L7 ETM+ SLC-off Product Development

- **Phase 0 – SLC-off Products – Released in October 2003**
  - Standard L0R and L1G Products that Include Scan Gaps
  - Search and Order Systems Use Lines and Numerical Scale on Existing Browse to Illustrate Impacts on Data Products
  - Selectable Interpolation for L1G Products Followed Soon After
- **Phase 1 – Initial Gap-filled L1G Products – Released May 2004**
  - SLC-off to SLC-on Gap-filled Product Using Histogram Matching
  - Scan Gap Mask Included to Indicate the Origin of Each Pixel
- **Phase 2 – SLC-off / off Gap-filled Products – Released Nov 2004**
  - Modified the Histogram Matching Gap-fill Approach to Use an “Adaptive Window” Size to Generate Improved Fill Pixel Values
  - Scan Gap Mask Modified to Accommodate Multiple “Fill” Scenes
  - Developed a Gap Phase Statistic and New Browse to Aid in Ordering

Landsat Mission Data Gap

- **The Earth observation community is facing a probable and pending gap in Landsat data continuity before OLI data arrive in 2010**
  - Landsat 5 limited lifetime/coverage
  - Degraded Landsat 7 operations
  - Either or both satellites could fail at any time: both beyond design life
- **Urgently need strategy to reduce the impact of a Landsat data gap**
  - Landsat data are used extensively by a broad and diverse community
  - A data gap will interrupt a 33-yr time series of land observations during a critical time period
- **Landsat Program Management must determine utility of alternate data sources to lessen the impact of the gap and feasibility of acquiring data from those sources in the event of a gap**
- **A Landsat Data Gap Study Team, chaired by NASA and the USGS, has been formed to analyze potential solutions**

Landsat Data Gap Study Team

Objective

- **Recommend options, using existing and near-term capabilities, to populate the USGS National Satellite Land Remote Sensing Data Archive with science quality data**

  -- Consistent with the Land Remote Sensing Policy Act of 1992

Approach

- **Identify data "sufficiently consistent in terms of acquisition frequency, geometry, spatial and spectral resolution, radiometric calibration, coverage characteristics, and spatial characteristics with previous Landsat data…"**

  -- Consistent with Management Plan for the Landsat Program

- **Process**
  - Identify acceptable gap-mitigation specifications
  - Identify existing and near-term capabilities
  - Compare capabilities to acceptable specifications
  - Synthesize findings and make recommendations

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Systems Considered

- IRS ResourceSat – 1, 2 (India)
- CBERS – 2, 2A, 3, 4 (China & Brazil)
- RapidEye – 1, 2, 3, 4, 5 (Germany)
- DMC (Algeria, Nigeria, UK, China)
- Terra/ASTER (US & Japan)
- High-resolution U.S. commercial systems
- SPOT – 4, 5 (France)
- ALOS (Japan)
- EO-1/ALI (US)

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EO-1 ALI Image Assessment System (ALIAS)

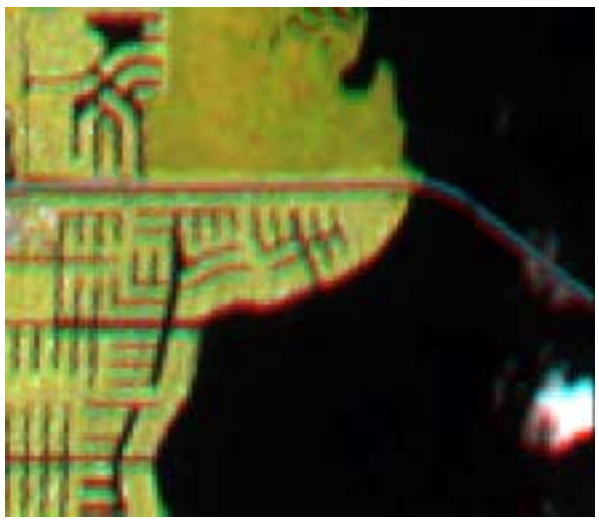
- **Major assumptions in the development of ALIAS**
  - LDCM OLI will be similar to ALI “push broom” design
  - NASA and USGS will remain as partners in LDCM Cal/Val
- **Builds on successes of Landsat 7 IAS and EO-1 SVT**
- **Goals of the ALIAS prototype**
  - Mitigate the risk associated with losing key knowledge, experience, and personnel before the LDCM mission fully commences
  - Generate an IAS prototype based on the algorithms and software used for EO-1 ALI and Landsat 7 ETM+ analyses
  - Reuse Landsat 7 IAS to the maximum extent possible
- **Partners**
  - USGS/EROS
  - NASA/GSFC
  - MIT/Lincoln Laboratories
  - South Dakota State University

ALIAS Overview - continued

- **Prototype Design Key Attributes**
  - Demonstrate the technical feasibility of trending radiometric performance data on a detector-by-detector basis (Bulk Trending)
    - Bulk Trending stores a basic data from all scenes in archive
    - Detailed Trending stores detailed information from specific processing on specific scenes
  - Develop and exercise a very large IAS database (>5TB) of trended sensor information and extrapolate production system performance
  - Geometrically correct and mosaic the Sensor Chip Assembly (SCA) image strips into a seamless image
  - System architecture to support a virtual IAS concept where IAS analysts have remote access (GSFC)
  - Develop Calibration Parameter File (CPF) information in a logical database along with trended data (still supports a CPF delivery)

ALI L1Gs Improvement

- Improved the VNIR/SWIR band registration
- New algorithm to correct leaky pixels in the output product
- Newly identified varying and inoperable detectors are corrected in the output product
- Released March 7, 2005



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ALIAS: EO-1 & LDCM Synergies

- **EO-1 ALI Benefits**
  - Radiometric/Geometric algorithms & CPF used in EO-1 Product Generation
    - ALI L1Gs product released in December 2004
    - ALI L1Gt product released in Summer 2005
  - EO-1 user community benefits greatly, and ALIAS team benefits from external validation & user feedback of corrected products

- **LDCM Benefits**
  - ALI data and ALIAS prototype allow the LDCM Project to minimize risks of new technology and ground processing algorithms
  - Stimulates early research and development of needed calibration and correction algorithms
  - Trending database design and evaluation (database to grow to ~5TB)
  - Collaborative (GSFC & EROS) workflow simulation & validation
  - Prepares instrument team for acceptance testing and On-orbit Initialization and Verification (OIV)

LDCM Update

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LDCM Update

- Interagency consensus with Office of Science & Technology Policy (OSTP) that NPOESS currently is not the best platform for the Operational Land Imager (OLI)
- The specifics of a “free-flyer” OLI option are yet to be determined
- USGS will establish and lead a Landsat Data Continuity Science Team
  - Core team with representation by USGS, NASA, and NOAA(?)
  - External members selected through competitive solicitation
  - Announcement expected in December
  - Request for Proposals in early 2006

LP DAAC Status: ASTER

- **ASTER corrections being implemented**
  - Geometric errors (georeferencing)
    - Earth nutation – correction implemented by GDS
    - Earth rotation (0-200m day, 0-700m night) - correction implemented by GDS
    - Height above sea level (0-500m) – to be implemented in ASTER L1A+ PGE in April, 2006
  - SWIR cross-talk
    - Stray light from band 4 to bands 5&9 – to be corrected in new delivery of Level-2 PGEs (Linux, S4PM)
- **LP DAAC will now be generating ASTER Level-1B and Level-2 products from any Level-1A data in the archive**
  - Over 1.2 million ASTER L1A, of which ~25% processed to L1B by ASTER GDS
  - Billing and accounting to be implemented for all ASTER data products (except for NASA PIs and Educators)

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MODIS Direct Broadcast

- New geolocation processing code includes terrain correction – corrects artifacts identified in composite products
- Data Products:
  - Calibrated radiances (Level-1B)
  - Surface reflectance
  - Vegetation Indices (250m, 500m, 1000m)
  - Swath-based and gridded products
  - HDF and Geotiff formats
- Implemented daily-incremented 7-day NDVI composites for conterminous U.S. using Aqua MODIS

Commercial Providers and Cal/Val

- **USGS serves users having divergent requirements**
  - Science users
  - Resource management users
- **Increasingly, these requirements are merging**
  - How to maintain transparency required by science when using data provided by commercial providers?
- **What frameworks exist to incorporate commercial products into a peer-reviewed environment?**
  - Existing frameworks:
    - US: Joint Agency Commercial Imagery Evaluation (JACIE)
    - International: **WGCV/ISPRS Joint Working Group**
  - NRC/Space Studies Board Assessments
    - Transforming Remote Sensing Data into Information and Applications (NAP 2001)
    - Toward New Partnerships In Remote Sensing: Government, the Private Sector, and Earth Science Research (NAP 2002)
    - Using Remote Sensing in State and Local Government: Information for Management and Decision Making (NAP 2003)

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