Cross-calibration of current Landsat sensors with foreign Landsat-class sensors for long-term monitoring of land surface processes

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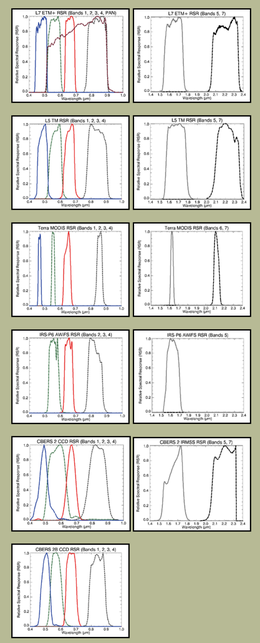
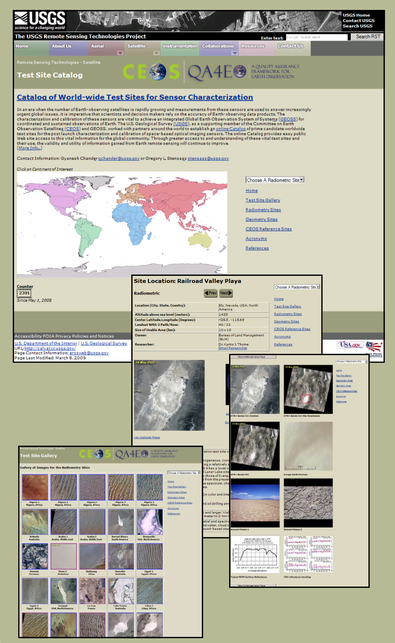
Overview

- Goal: The goal of this proposal is to extend the theoretical and applied understanding of radiometric cross-calibration of multiple sensors in support of continued long-term studies of the Earth's land surfaces
- Need for Cross-calibration
  - Tie similar & differing sensors onto a common radiometric scale
  - Provide mission continuity, interoperability, and data fusion
  - Essential where on-board references are not available or where vicarious calibration is not feasible
  - Critical to coordinate observations from different sensors, exploiting their individual spatial resolutions, temporal sampling, and information content to monitor surface processes

RSR Comparison



Catalog of Worldwide Test Sites



Relevance

- The proposed work supports USGS & NASA's long-term commitment to LRS by specifically creating a bridge between the calibration record of current Landsat sensors and the upcoming LDCM sensor, as well as providing tools and techniques applicable to other current and future sensors
- This project is critical for the understanding of international sensors to support the Landsat Data Gap (LDG) mitigation efforts
- This project will develop a reliable, low-cost method for continual monitoring of data quality from multiple satellites, and provide assessments of the impact of this improved knowledge in real, ongoing scientific applications
- Cross-calibration capability will prove crucial to ensuring accuracy, interoperability, and reliability between multiple data sources in a NLIP/GEOSS environment

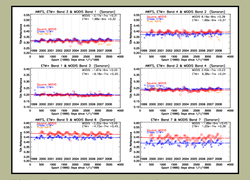
Satellite Coincident Imaging Tool

- A coincident imaging tool was developed to identify the potential near-simultaneous surface observations of Earth from sensors that have different ground tracks and repeat cycles

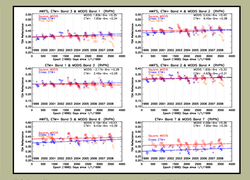
Monitoring On-orbit radiometric stability

- A methodology for long-term monitoring of the on-orbit radiometric stability using pseudo-invariant test sites was developed

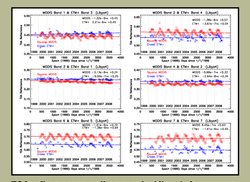
Platform	Terra	Landsat 7	IRS-P6
Sensor	MODIS	ETM+	AWiFS
Number of bands	36	8	4
Spatial resolution	250 m, 500 m, 1 km	15 m, 30 m, 60 m	56 m (nadir), 70 m (edge)
Swath	2360 km	187 km	740 km
Spectral coverage	0.4~14 µm	0.4~12.5 µm	0.52~1.7 µm
Pixel quantization	12 bit	8 bit	10 bit
Launch date	Dec 18, 1999	Apr 15, 1999	Oct 17, 2003
Orbit type	Sun synchronous	Sun synchronous	Sun synchronous
Altitude	705 km	705 km	817 km



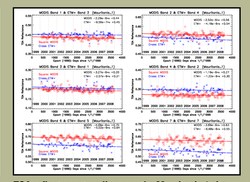
TOA reflectance trending over the Sonoran site



TOA reflectance trending over the RVPN site



TOA reflectance trending over the Libya 4 site



TOA reflectance trending over the Mauritania 1 site

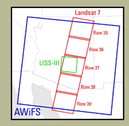
- The plots show the long-term Top-of-Atmosphere (TOA) reflectance trending of the spectrally matching bands
- The TOA reflectances from ETM+ (blue cross), AWiFS (orange plus), & MODIS (red square), have been trended and the error bars (in black) denote the 1-sigma deviation from the mean TOA reflectance within the homogeneous regions of interest (ROI)
- The annual oscillations are caused by BRDF effects. Linear equations are fitted, showing very small slope and constant offsets
- To evaluate the long-term stability of the sensors, average percent differences between the TOA reflectances and RMSE's were computed for each band

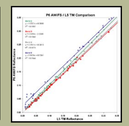
Primary Objectives

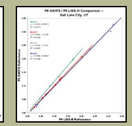
- Research & Development (R&D): Develop a robust approach for cross-calibration sensors with an initial focus on Landsat 5/7 and the Indian Remote Sensing Satellite Payload (IRS-P6) sensors
- Sensitivity Studies: Investigate & quantify the uncertainties inherent in the cross-calibration process. These include error sources such as differing spectral profiles, spatial and radiometric resolution differences, geometric registration, BRDF and atmospheric effects
- Land Cover Validation: Validate the cross-calibration approach by analyzing the LCLUC products produced from cross-calibrated scenes. The suitability of IRS sensors for land cover applications (e.g., quantifying fractional landscape components, and land change analysis) will be evaluated

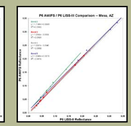
Cross-calibration

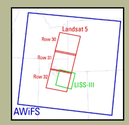
- To understand the absolute radiometric calibration accuracy of IRS-P6 AWiFS and LISS-III sensors, image pairs from these sensors were compared to images from the L5 TM & L7 ETM+ sensors. The approach involves calibration of surface observations based on image statistics from areas observed nearly simultaneously by the two sensors

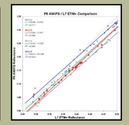


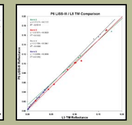


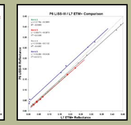












- The TOA reflectance from the Landsat sensor is compared against the TOA reflectance of the AWiFS and LISS-III sensors
- The average TOA reflectance estimates obtained from these sensors agree within 13 percent

Summary & Future Work

- Developed worldwide test site catalog and coincident imaging tool
- Identified test sites with good coverage of Landsat & P6 data
- Created the tools to perform the long-term monitoring of the on-orbit radiometric stability of the potential LDG sensors
- Performed initial cross-calibration between Landsat & IRS-P6 sensors. Additional work is underway to characterize the uncertainties due to differing spectral profiles, geometric registration, spatial and radiometric resolution, BRDF, and atmospheric effects
- Initiated application studies to evaluate the suitability of the LDG sensors for Land Cover applications (eg., quantifying fractional landscape components, land-change analysis) through a comparison with legacy data sets generated from Landsat data