

NASA/HQ Update

CEOS Working Group on Calibration and Validation

Chiang Mai, Thailand, October 2006

Carlos Paz, Argentina, March 2005



Frascati, Italy, November 2005





Budapest, Hungary, May 2006

Towards Filling the Landsat Data Gap: An Update

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Land-Cover/Land-Use Change Program

The Landsat Program Issues

- Developing the capability for periodic inventories of land cover from space is critical to studies of land-cover and land-use change
- The next Landsat will be a free flyer (plans for having it on NPOESS scratched)
- Landsat-7 data are only partially useful - at the edge of the scan there are gaps. New, improved products are available at USGS. Their quality is analyzed.
- Landsat-5 malfunctions from time to time. Good L-5 2004-2006 data are available.

Mid-Decadal Global Land Survey: Summary

- Develop a global orthorectified dataset from Landsat or Landsat-like observations based on measurements circa 2005 (2004-2006)
- Use Landsat-5 ground stations data where available, Landsat-7 composites, ASTER to fill the gaps, EO-1/ALI over islands
- If necessary fill the gaps with foreign data
- USGS leads Phase I – data compilation
- NASA leads Phase II – data processing
- Phase III – development of LCLUC products

Data Gap Issues

- Both Landsat-5 and -7: out of fuel in 2009
- Next Landsat (LDCM): ~2012
- Anticipated 2-3 years of Landsat data gap
- Steps are undertaken to prepare for use of non-US sources of Landsat-like data

Preliminary characterization of two non-US satellite sensors

- China Brazil Earth Resources Satellite (CBERS)
 - HRCCD
 - IRMSS
- Indian RESOURCESAT IRS-P6
 - AWiFS (Advanced Wide Field Sensor)
 - LISS-3
 - LISS-4

CBERS-2 Overview

CBERS-2 Sensors

- **IRMSS (Infrared Multispectral Self Scanner)**

- Scanning sensor, with scanning mirror and 2 scan line correctors.
- 1 warm focal plane for Pan Band, 2 cooled planes for SWIR and thermal bands
- 4 bands, 80m GSD (Pan and SWIR) & 160m GSD (Thermal) GSD.
- 120 km swath, 26 day repeat

- **HRCCD (High-Resolution CCD Sensor)**

- Pushbroom sensor, with one focal plane with 3 offset CCD arrays.
- 5 bands (4 Vis, 1 IR), 20m GSD, 113 km swath, 26 day repeat.
- Steerable up to +/- 32 deg across track to obtain stereoscopic imagery.
- Signal acquisition system operates in two channels.

Ch1: B2, B3 and B4, Ch2: B1, B3 and B5

- **WFI (Wide Field Imager)**

- Pushbroom sensor with 2 spectral bands (red and near-ir similar to HRCCD)
- 260m GSD, 885 km swath, 3 to 5 day repeat

Closest to Landsat: combination of IRMSS with HRCCD

CBERS-2 Characterization Summary

Based upon CRESDA (China) data:

- **Product assessments reveal production inconsistencies for both HRCCD and IRMSS.**
- **IRMSS assessments indicate significant issues with data format and lack of technical information.**
- **HRCCD radiometric assessments indicate**
 - **artifacts that can be characterized and or corrected,**
 - **relative gain and bias corrections applied during Level-1 processing,**
 - **band dependent noise and bias instabilities,**
 - **good cross calibration agreement with Landsats 5, 7.**
- **HRCCD geometric assessments indicate systematic errors.**

CBERS Current Status

- IRMSS inoperable since '05
- HRCCD operations interrupted in May '06 due to power supply anomaly
- CBERS-2B scheduled for Spring '07 to include HRCCD, but no IRMSS
- But there is a hope: CBERS-3 in 2009

In the Meantime...

Indian Resource Satellite

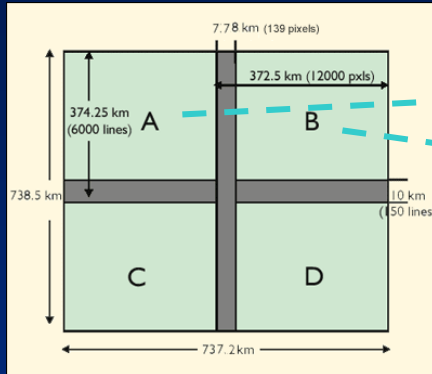
IRS-P6 Overview

RESOURCESAT-1 Sensors

- **Medium Resolution Linear Imaging Self-Scanner (LISS-III)**
 - 4 separate axis aligned telescope assemblies, one assembly per band.
 - 4 bands with nadir only view, 23.5m GSD, 141 km swath, 24 day repeat.
- **Advanced Wide Field Sensor (AWiFS)**
 - 2 separate electro-optic modules (cameras) tilted ~12.0 degs wrt nadir.
 - 4 bands, 56 meter GSD, 740 km swath, 5 day repeat.
- **High Resolution Linear Imaging Self-Scanner (LISS-IV)**
 - Single telescope and lens assembly.
 - 3 bands, 5.8 meter GSD, steerable, 23km or 70 km swath, 5 day repeat.



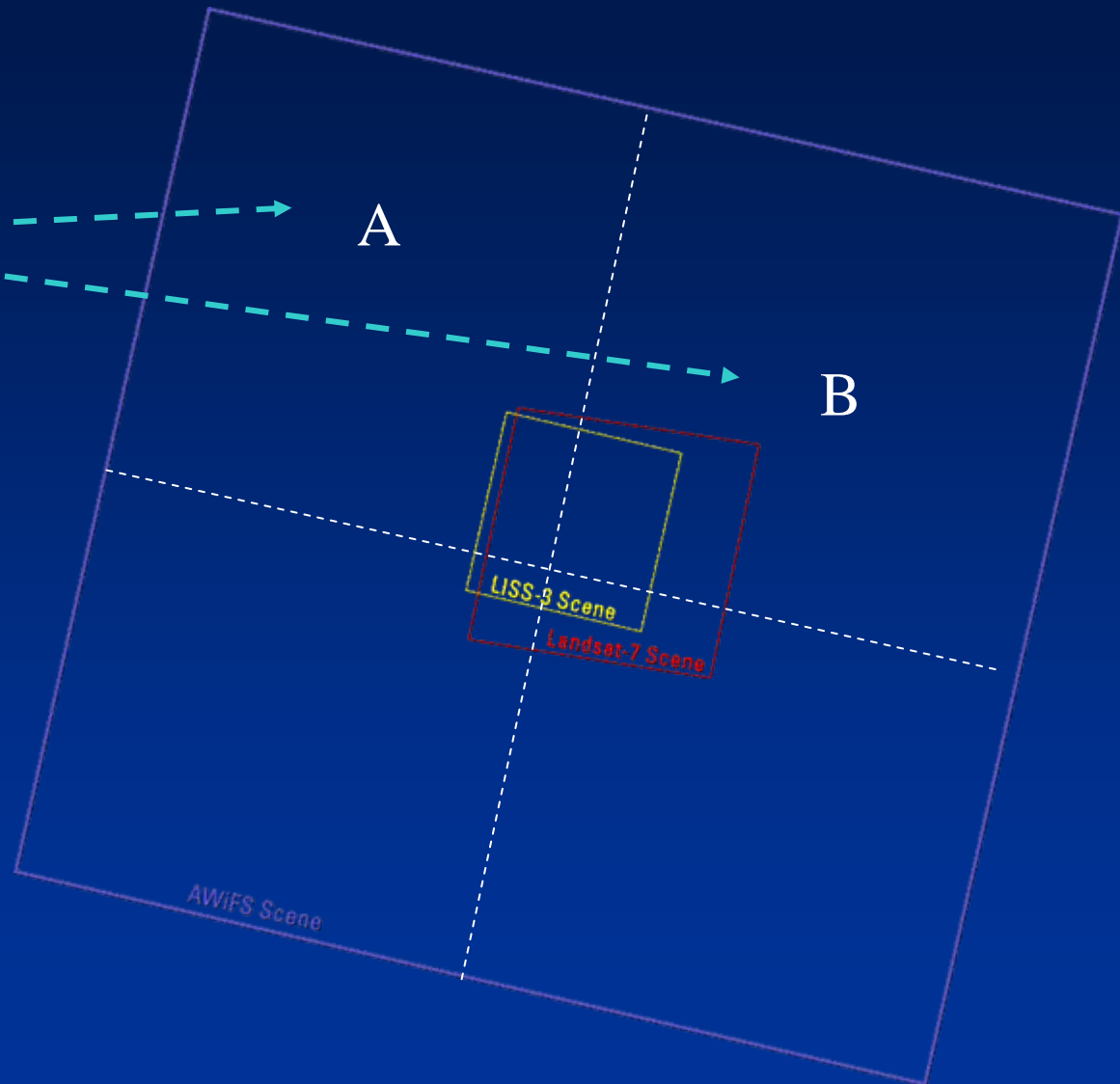
IRS-P6 Scenes



AWiFS quad
(scene) layout

Quads A&C
imaged by
Camera A

Quads B&D
imaged by
Camera B

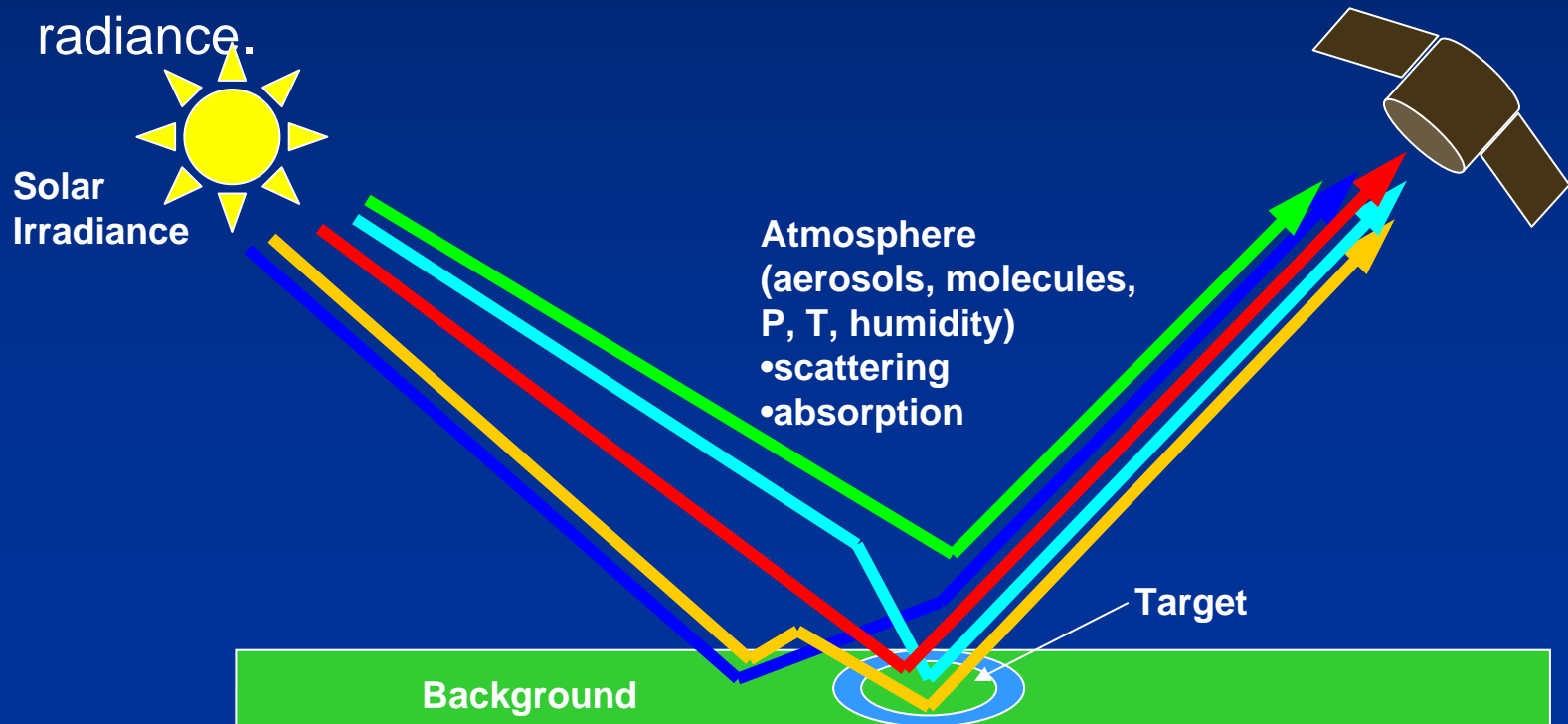


IRS-P6 DCWG Characterization Summary

- **Radiometric assessments indicate**
 - artifacts that can be characterized and/or corrected,
 - calibration in good agreement with specifications.
- **Geometric assessments indicate**
 - correctable systematic errors in band-to-band results,
 - image-to-image results in good relative agreement.
- **Spectral results indicate**
 - agreement with Landsat-7 ETM+ bands 2-4,
 - lack of Landsat-7 Band 1 or 7 spectral equivalents.

Reflectance-based Vicarious Calibration Approach

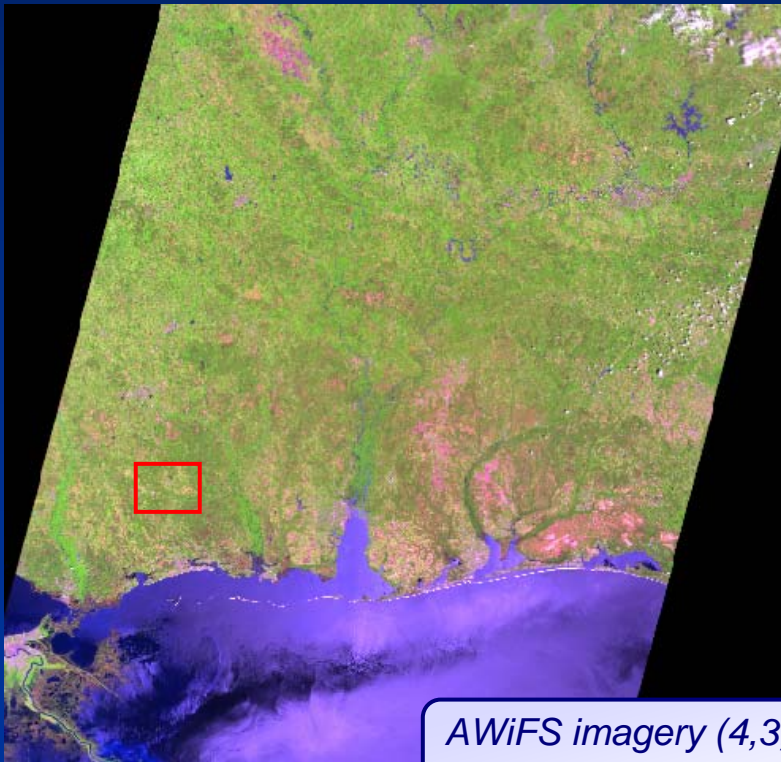
- Measure target/ground reflectance coincident with the satellite acquisition
- Measure atmospheric aerosols, and pressure, temperature and water vapor profiles coincident with the satellite acquisition.
- Use these measurements along with acquisition geometry/location parameters as input into a radiative transfer model to predict at-sensor radiance.



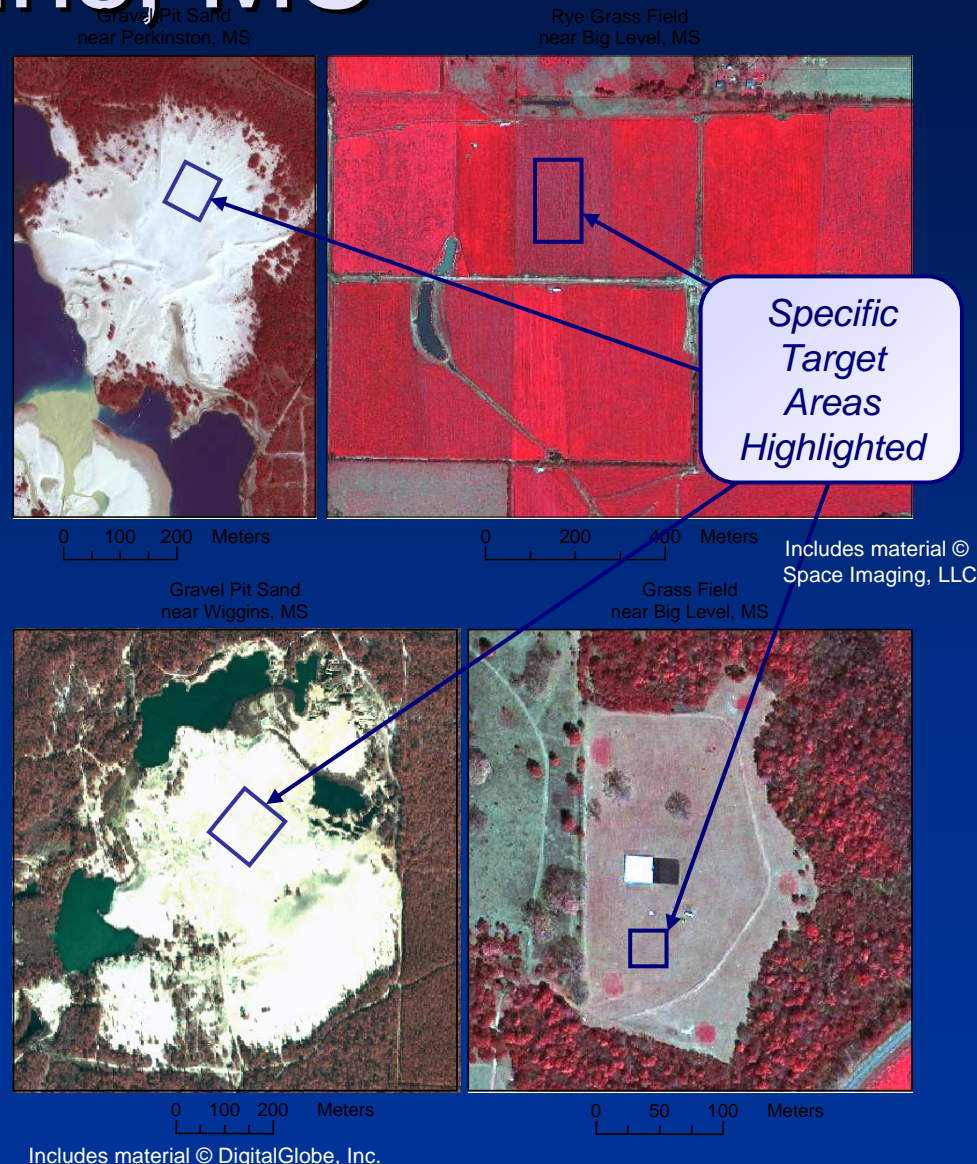
Selected Targets – Wiggins, MS

Four selected targets of opportunity near Stennis Space Center are hundreds of meters across:

- Two gravel pit sand sites



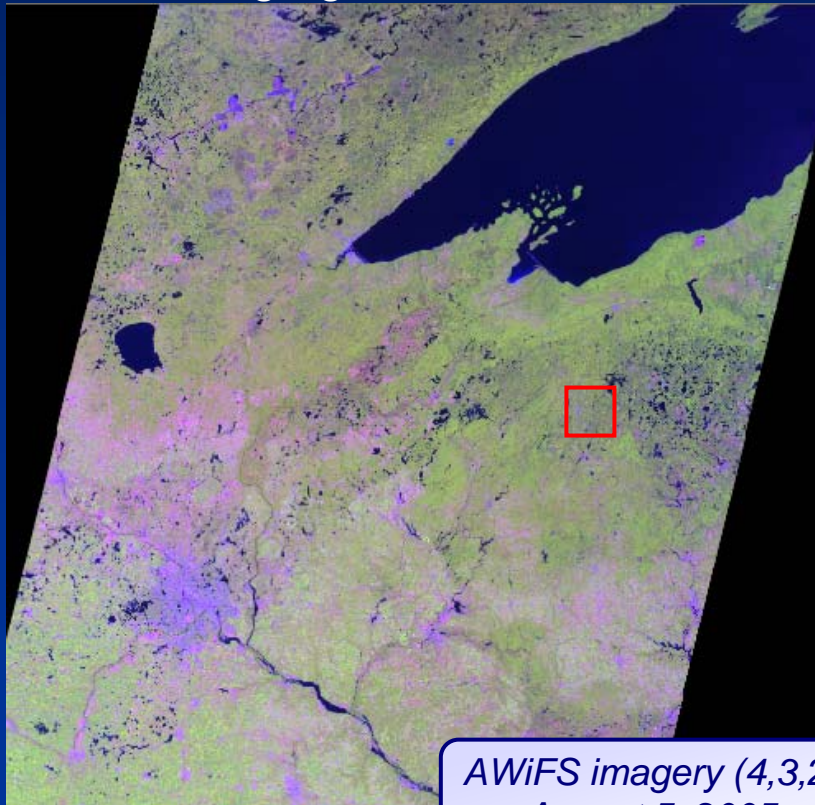
AWiFS imagery (4,3,2)
April 27, 2005



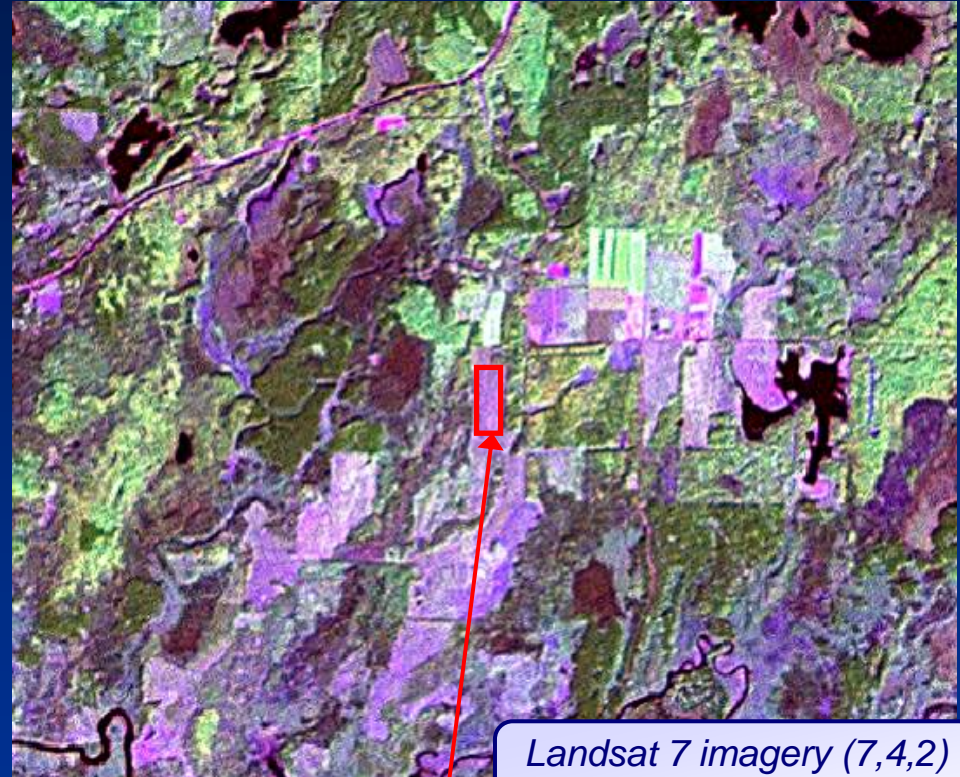
Selected Targets - Park Falls, WI

A target of opportunity was found near an Aerosol Robotic Network (AERONET) site near Park Falls

- Large grass field



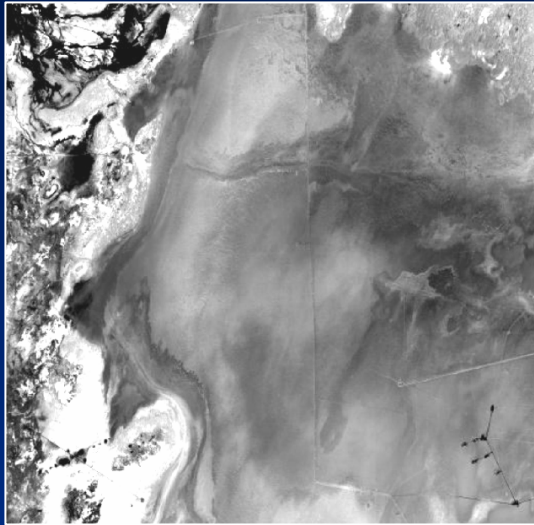
*AWiFS imagery (4,3,2)
August 5, 2005*



*Landsat 7 imagery (7,4,2)
August 5, 2005*

Target field 150 m x 400 m

U.S. Southwest Acquisition Sites



Railroad Valley, NV
38.51 °N, 115.69 °W

Bright and Uniform
High reflectance
minimizes atmospheric
uncertainties

High Elevation
All acquisition sites above
3500 ft elevation

Minimal Precipitation and
Cloud Cover

Maintains stability and
increases chance of
acquisition

Large
Minimizes adjacency
effects



Ivanpah, CA
35.53 °N, 115.38 °W



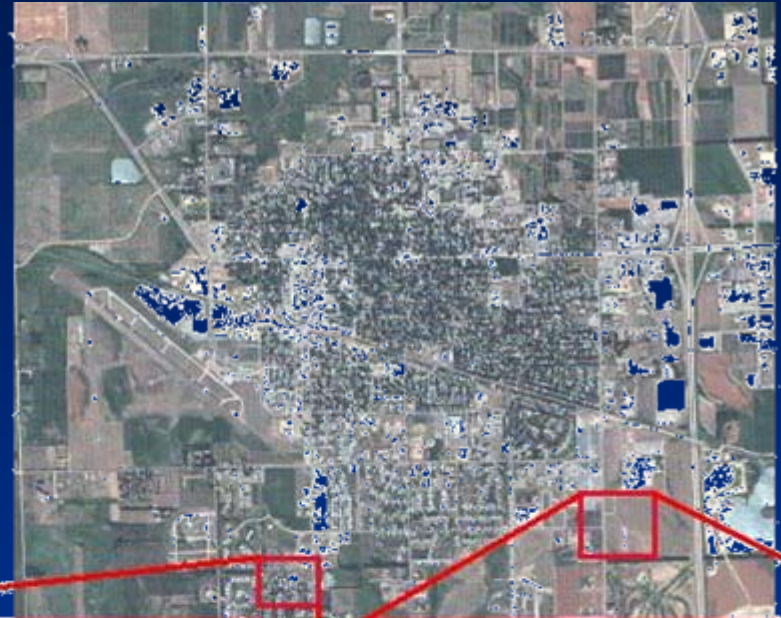
Brookings, SD, Acquisition Site

Site: South Dakota State University campus, 3M manufacturing plant, town, surrounding grassy fields and airport

Elevation: 500 m

Center Point: 44.30° N, 96.81° W

Targets Evaluated: Cut Grass, Tall Grass



Initial Radiometric Calibration Coefficients

	Green	Red	NIR	SWIR
NASA Estimate				
Cal Coeff (W/m ² sr μm DN)	0.60 ± 0.02	0.46 ± 0.01	0.31 ± 0.02	0.056 ± 0.004
Offset	-5.49 ± 5.36	2.60 ± 3.89	-3.11 ± 6.69	-2.82 ± 2.15
AWiFS Provided				
Cal Coeff (W/m ² sr μm DN)	0.51 0	0.40 0	0.28 0	0.045 0
Offset				

AWiFS Results Summary

- The NASA team of University of Arizona, South Dakota State University, and NASA SSC produce consistent results
- The AWiFS calibration coefficients agree reasonably well with the NASA team estimate
- The NASA team will continue to assess AWiFS radiometric accuracy

Overall Summary

- Initial radiometry, spatial resolution, and geopositional accuracy assessments were performed
 - Radiometry is consistent with other similar systems
 - Spatial resolution consistent with pushbroom systems
 - Geopositional accuracy of non-orthorectified product not sufficient for many applications (but correction is possible)
- Research into the loss of several bands and spatial resolution needs to be further explored
 - Atmospheric correction based on second SWIR and blue band will be not be possible
 - Loss of spatial resolution and spectral bands will affect some land use land cover estimates
- Additional issue: large angular range -> anisotropy effects should be considered

Validation: CEOS Core Sites

- Need a universal set for validation of satellite products within the GEOS-CEOS-WGCV framework
- These sites will help foster calibration, validation, and intercomparison activities
- They can provide “sample data” for the research and user community to consider the compatibility of CEOS members data for their use
- Initial studies on Landsat data gap candidate fillers could utilize the CEOS core site if/when it were populated with CEOS member multispectral data with Landsat-like spatial resolution (<100m)



谢谢

спасибо

ขอบคุณครับ

Thank you!