AWiFS Radiometric Assessment

3 Presentations:

University of Arizona
Kurt Thome
South Dakota State University
David Aaron
SSC: Science Systems and Applications, Inc
Mary Pagnutti

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Kurt Thome
College of Optical Sciences, University of Arizona
kurt.thome@optics.arizona.edu

College of Optical Scie es

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Background

A wide range of sensor data has become available over the past five years

- The data from these sensors must be characterized to understand their quality and how they compare with other sensor's data
- The Indian Remote Sensing (IRS) P6 Advanced Wide Field Sensor (AWiFS) sensor is one of these
  - USDA Foreign Agriculture Service (FAS) approached NASA to perform an initial characterization (*Nov. 2004*)
  - Space Imaging was granted a license to receive and distribute AWiFS imagery from their ground station in Oklahoma (*Jan. 2005*)
  - Space Imaging agreed to provide 16 of images to Stennis Space Center for characterizations and USDA FAS agreed to share a portion of their AWiFS image archive

Background

SSC coordinating with multiple groups to assess radiometric and spatial quality of AWiFS data

- Reduces duplication of effort while improving product characterizations and hopefully leading to improved products
- “This” talk covers the radiometric results obtained by the groups at South Dakota State University, SSC, and University of Arizona
- All groups use the reflectance-based approach
  - Determine surface reflectance
  - Characterize atmospheric conditions
  - At-sensor radiance from radiative transfer code
  - Compare with radiance reported by sensor

Talk outline

- Overview of AWiFS sensor
- Description of University of Arizona approach
  - Reflectance-based approach
  - Ground-monitor radiometer approach
  - Results for AWiFS
- Description of South Dakota State approach and results
- Description of Stennis Space Center approach and results
- Summary of results for all groups

AWiFS description

AWiFS (Advanced Wide Field Sensor) is a multispectral camera on the IRS-P6 platform

- IRS-P6 (Indian Remote Sensing) Satellite also known as RESOURCESAT-1 is a multiple sensor platform
- IRS-P6 was launched on October 17, 2003 into a polar orbit from Satish Space Center by the Indian PSLV-C5
- Polar sun-synchronous orbit (altitude of 817 km)
- Platform carries
  - LISS-III
  - LISS-IV (mono and mx modes)
  - AWiFS A and B sensors

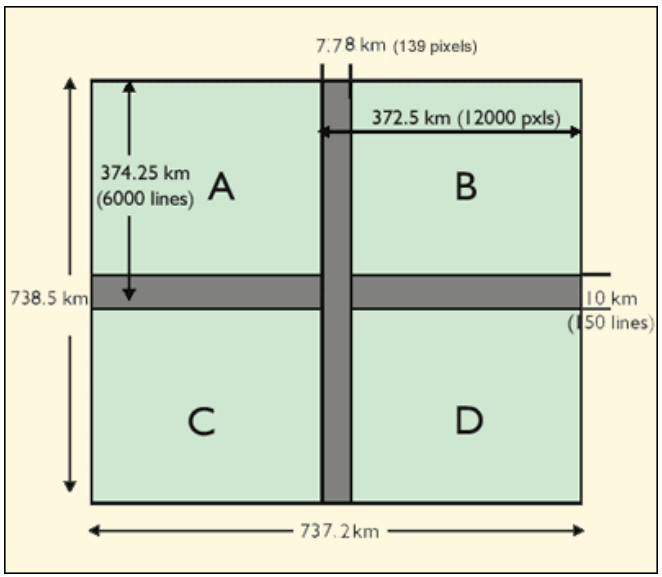
AWiFS description

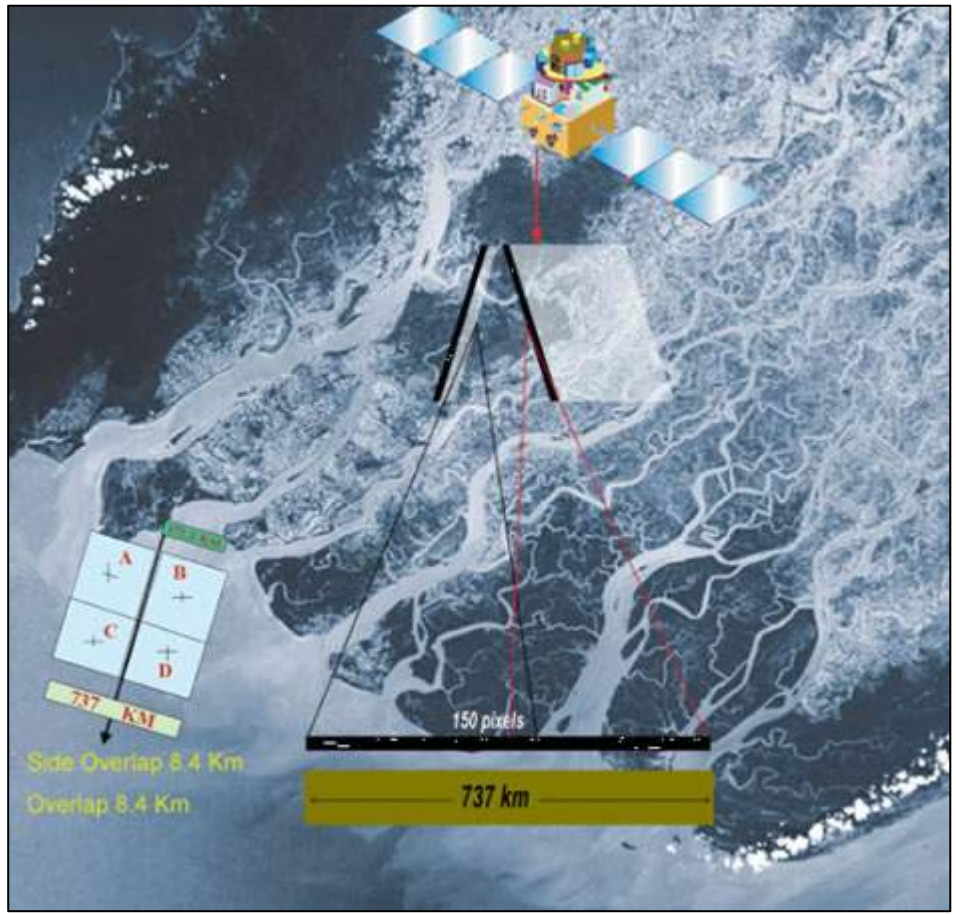
While spatial resolution is slightly poorer than Landsat the wider swath is an advantage

- Pushbroom-based sensor
- Four bands: 0.52-0.59, 0.62-0.68, 0.77-0.86, 1.55-1.70 µm
- Spatial Resolution is 56 m at nadir (70 m near edge of swath)
- Radiometric Resolution is 10 bit
- Swath is 740 km
- Repeat time is 5 days
- Design life is 5 years

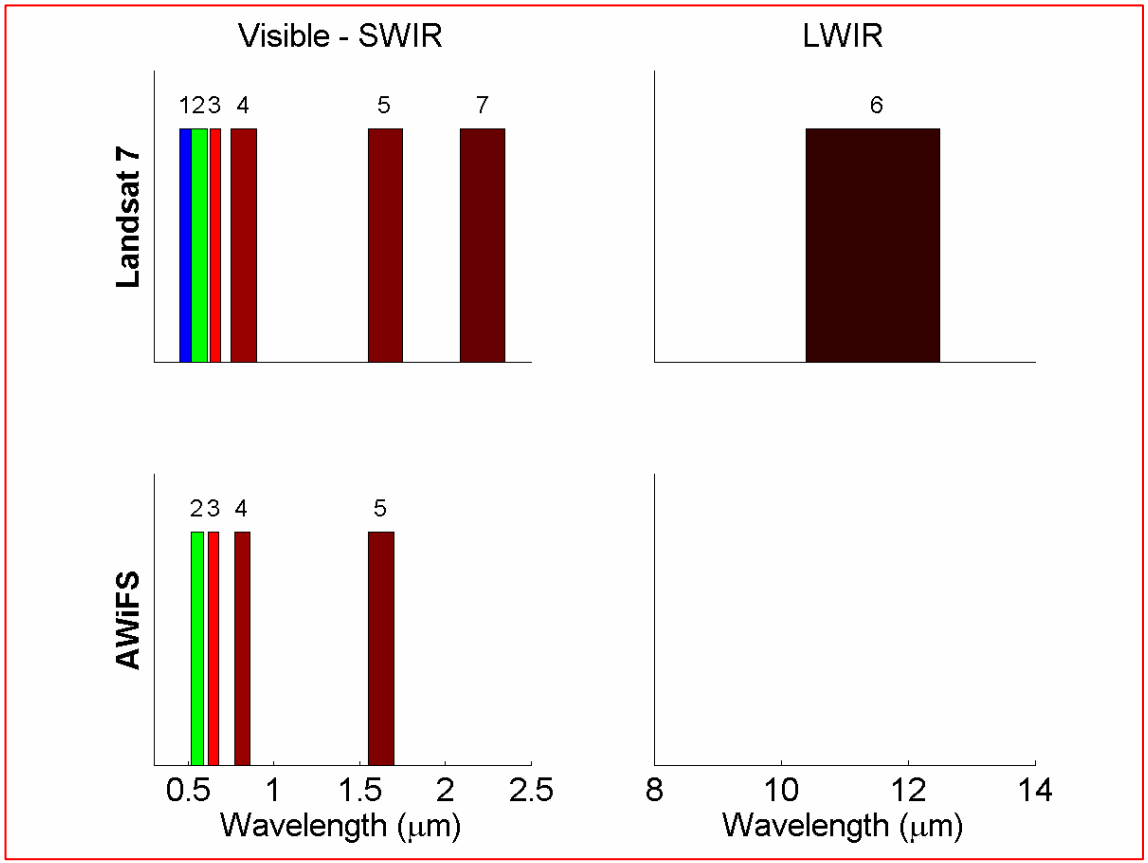
AWiFS Collection Approach

The AWiFS camera is split into two separate electro-optic modules (AWiFS-A and AWiFS-B) tilted by 11.94 degrees with respect to nadir





AWiFS – ETM+ comparison



Number of Samples

- ETM+: ~144 points per 40 acre field
- AWiFS: ~36 points per 40 acre field

Repeat Coverage

- Landsat 7: 16 days
- AWiFS: 5 days

Swath

- Landsat 7: 185 km
- AWiFS: 737 km

Bands

- Landsat 7 ETM+: 7 bands
- AWiFS: 4 bands (no blue, 2.2μm, thermal)

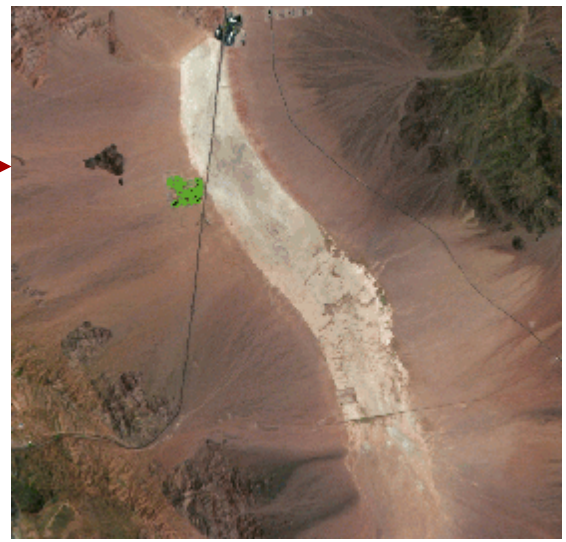
Reflectance-based approach

Measurements of surface reflectance of a homogeneous test site

Measurements of atmospheric conditions

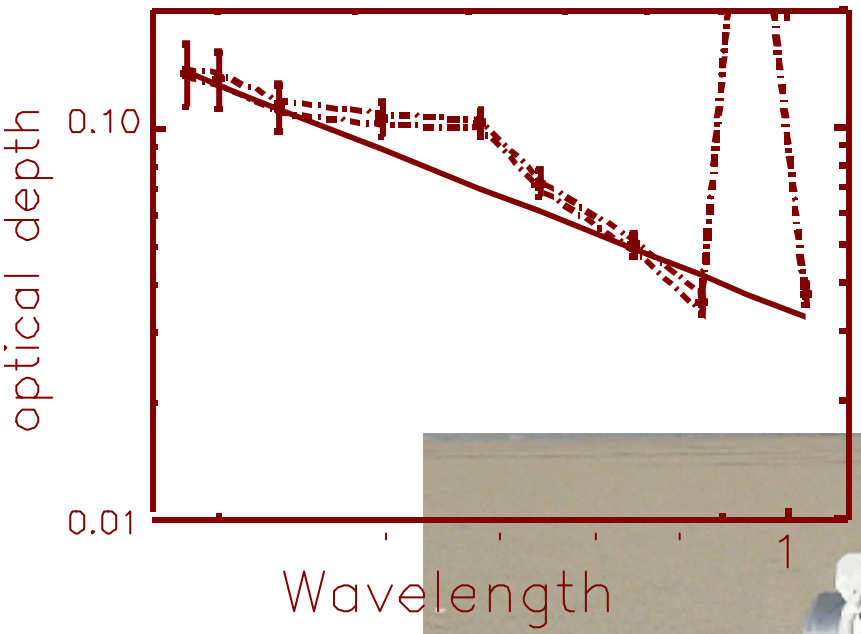
RTC Code

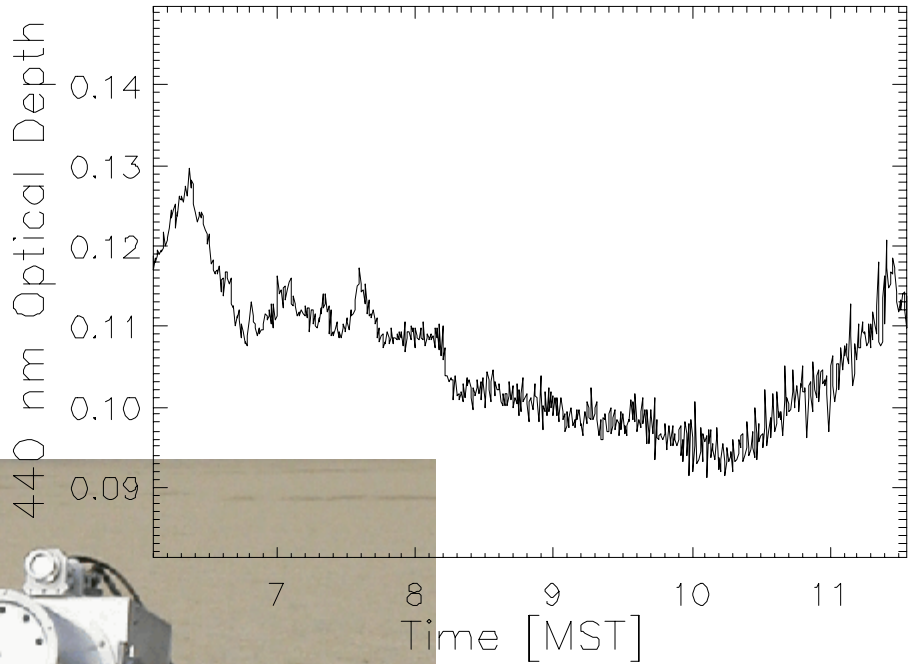
Predict at-sensor radiance for a selected area of the site and compare to imagery

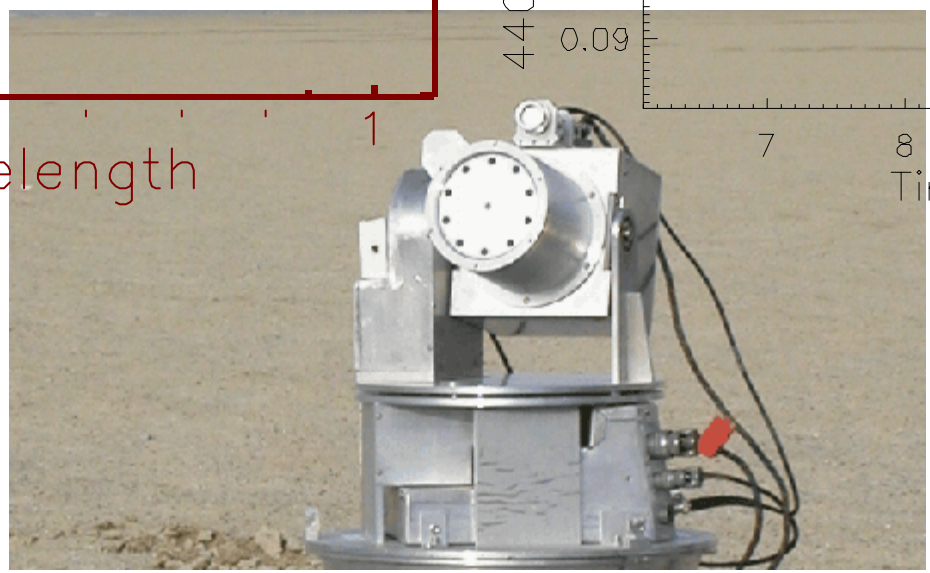


Atmospheric retrievals

Solar radiometer data provides optical depths as a function of wavelength and time







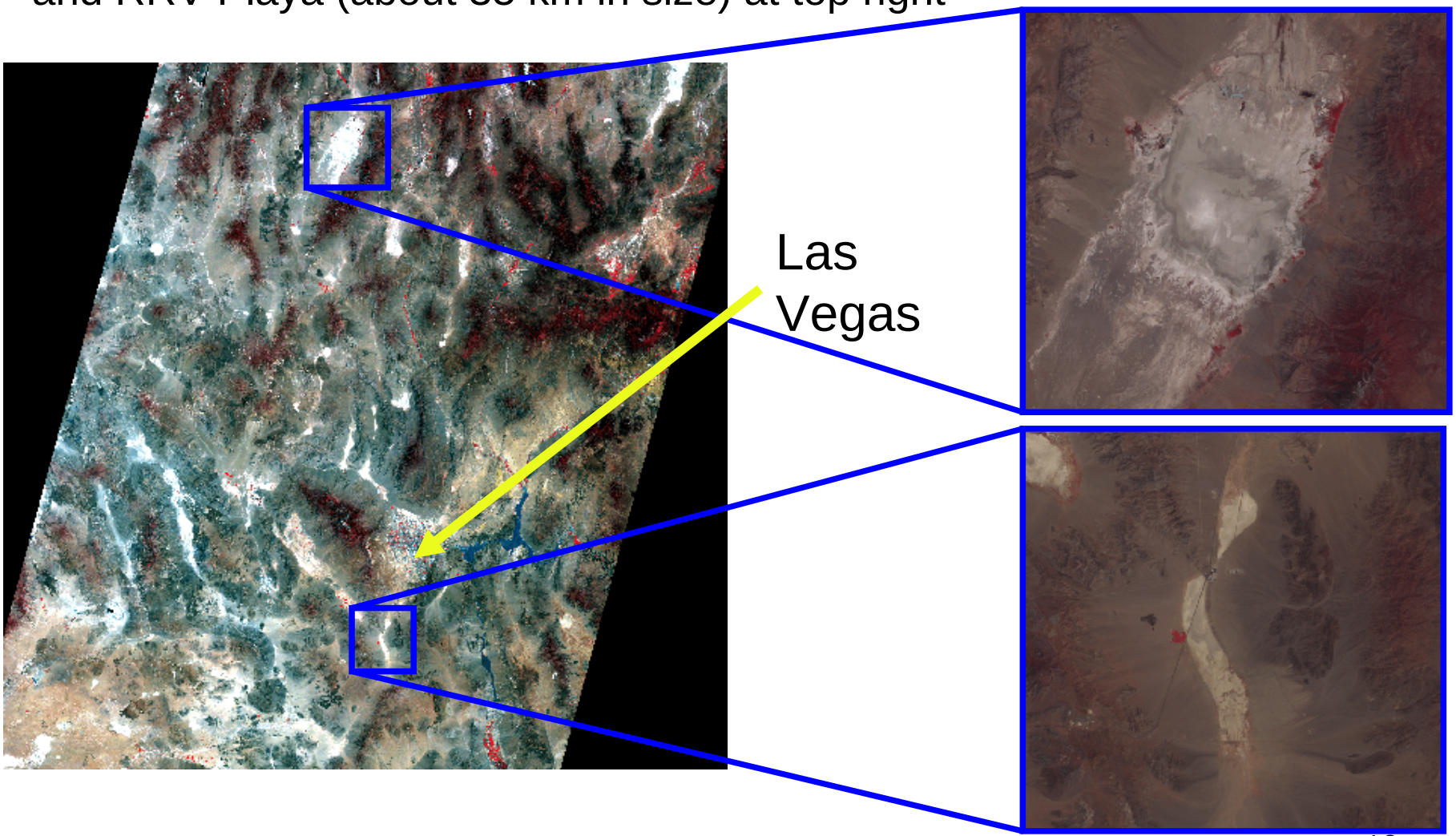
Reflectance retrieval

Characterized a 300 m by 80 m area in fashion similar to that used by other sensors

- Measurements of the site are made with reference to a panel of known reflectance
- Confidence that sampling approach is still valid since several 50-m sensors have been done previously for other projects
- Location of site relies on the geolocation information with the imagery

UofA Test Sites

Ivanpah Playa (3 km by 5 km) on the bottom right and RRV Playa (about 35 km in size) at top right



Data sets

Three attempts were made in summer 2005 to collect data for AWiFS

- June 18 at Ivanpah Playa
  - ETM+ and Terra on June 18
  - Landsat-5 overpass on June 17 at RRV Playa
  - Aqua overpass on June 19 at RRV Playa
- June 23 at Ivanpah Playa
  - Ikonos also on June 23
  - Smoke-filled skies
- August 10 at Railroad Valley Playa
  - ETM+ and Terra overpass on August 12
  - Orbview overpass on August 10
  - Landsat-5 overpass on August 13 at Ivanpah

Alternate approach

Wide swath of AWiFS allowed for an alternative data collection approach

- Sensor images both Ivanpah and Railroad Valley Playas on same date
- Offers an opportunity to obtain two calibrations on the same date between the two sites
  - One option is to have two groups deployed simultaneously
  - Other option is to have automated instrumentation operating at one site
- UofA has deployed automated sensors to characterize the surface and atmospheric conditions since 2003
  - Atmospheric characterization derived from AERONET data
  - Meteorological data collected with a met station
  - Site reflectance monitored with LED-based radiometers

Automated instrumentation

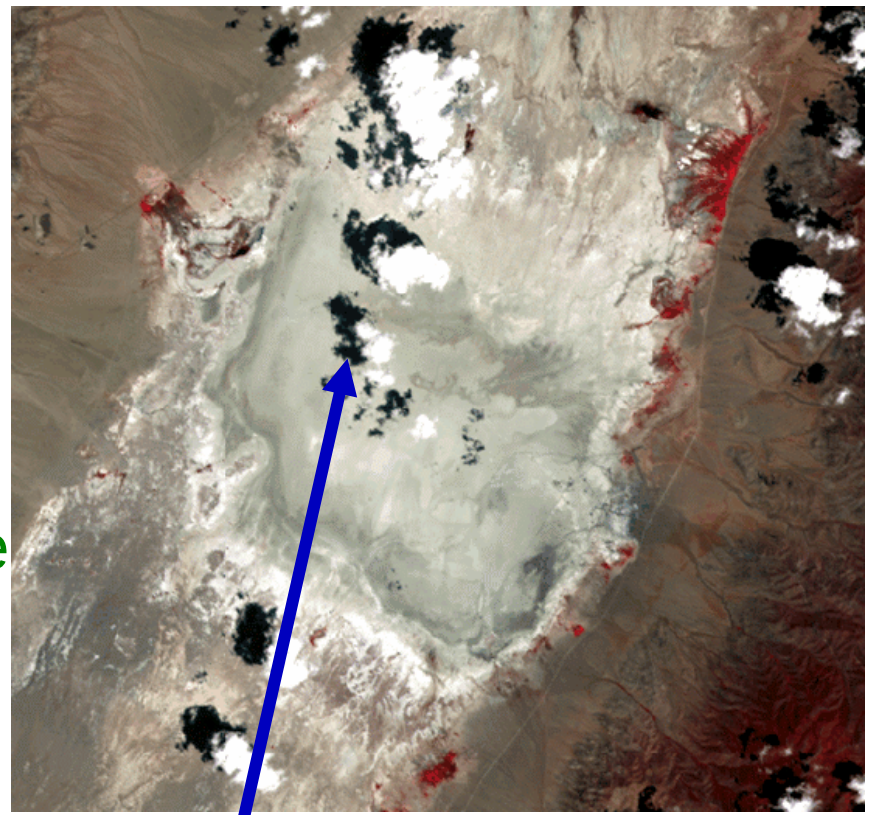
- AERONET instrument provides identical style inputs as obtained by on-site personnel operating similar instruments
- LED-based radiometer is a stationary, multi-spectral sensor
  - Built in house with green, red, and NIR bands
  - Currently have five such instruments deployed at RRV Playa

Radiometer evolution

Added data set

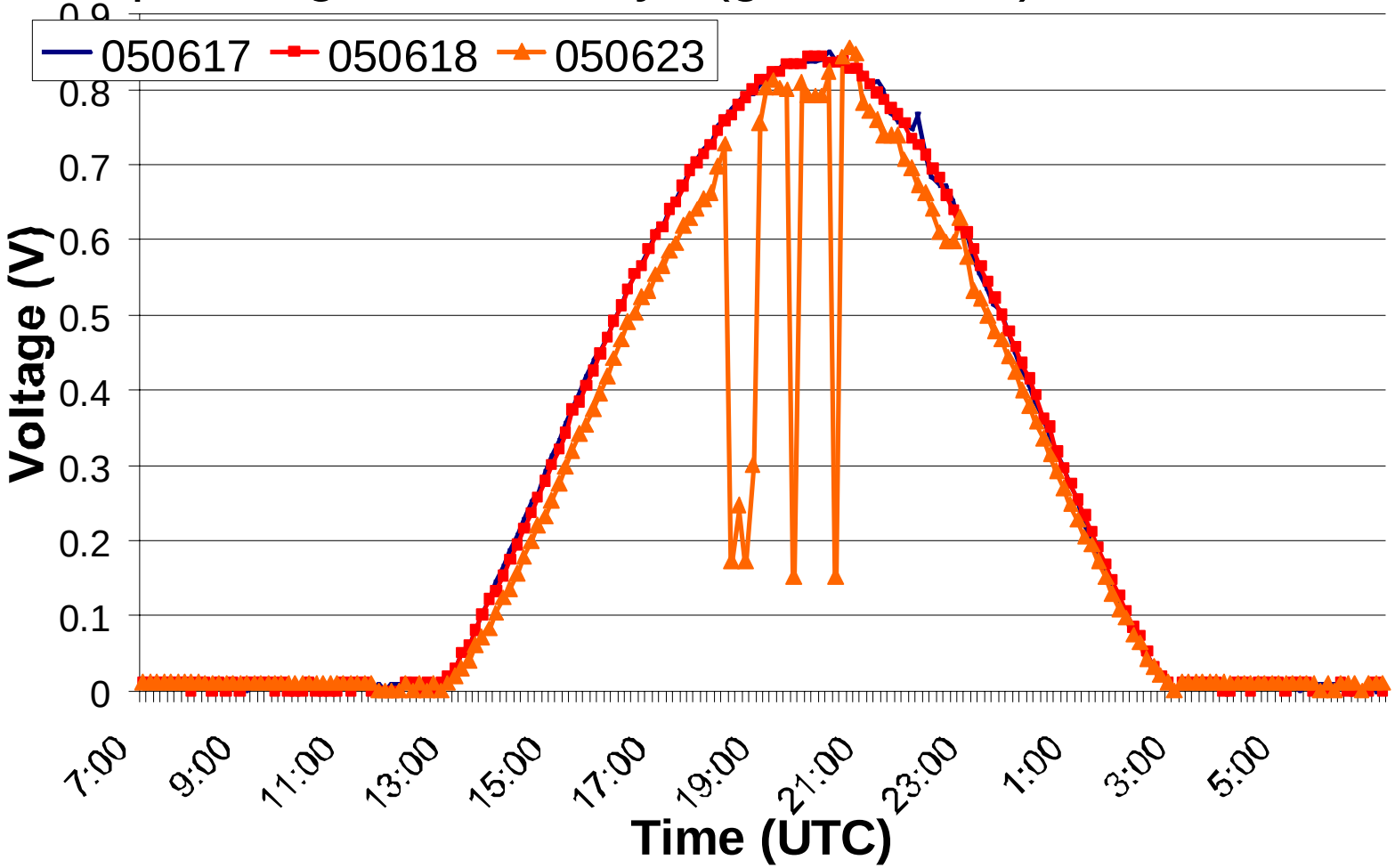
Automated data provided an opportunity to add two additional data sets for evaluation

- No added cost for imagery
- June 18 and 23 were targeted as Ivanpah Playa collections
  - Group was at Railroad Valley Playa just prior to these dates
  - Goal was to modify those collections based on the automated data
- Unfortunately, June 23 was cloudy at RRV Playa



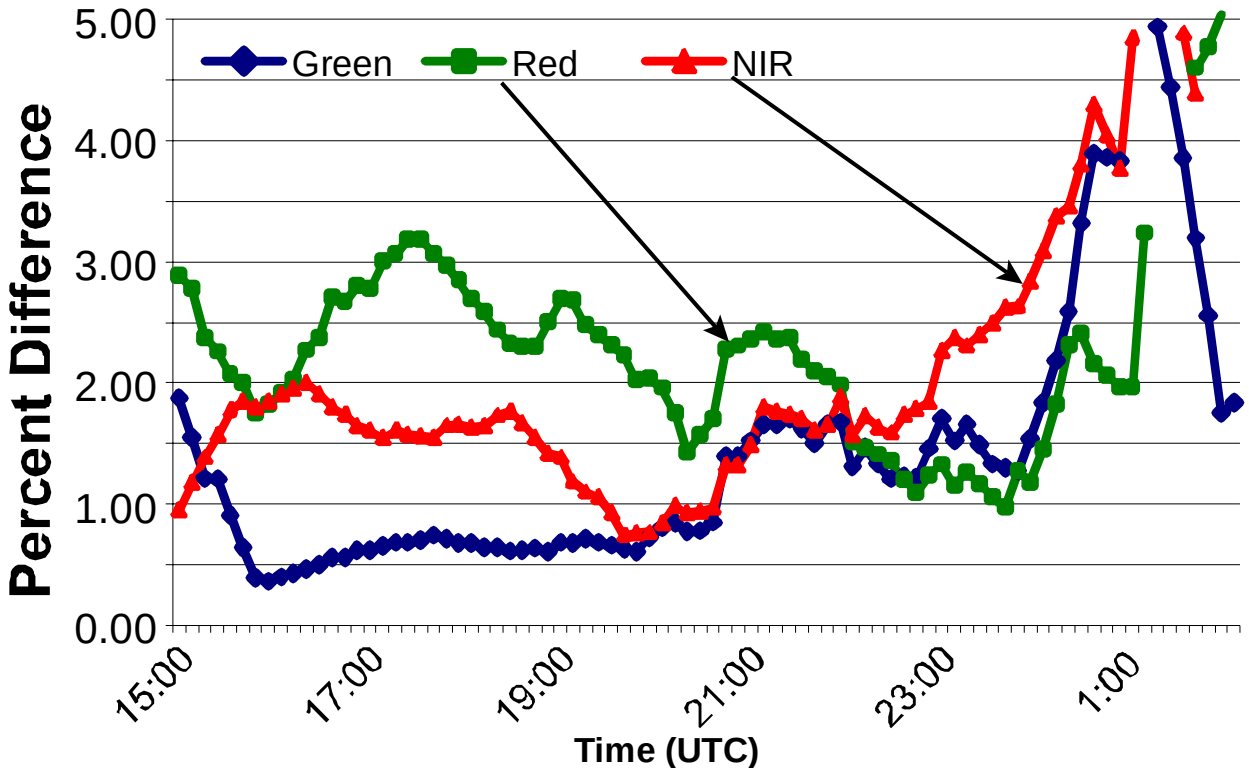
June 18 automated data

Raw data from automated radiometers operating at RRV Playa (green band)



Reflectance change

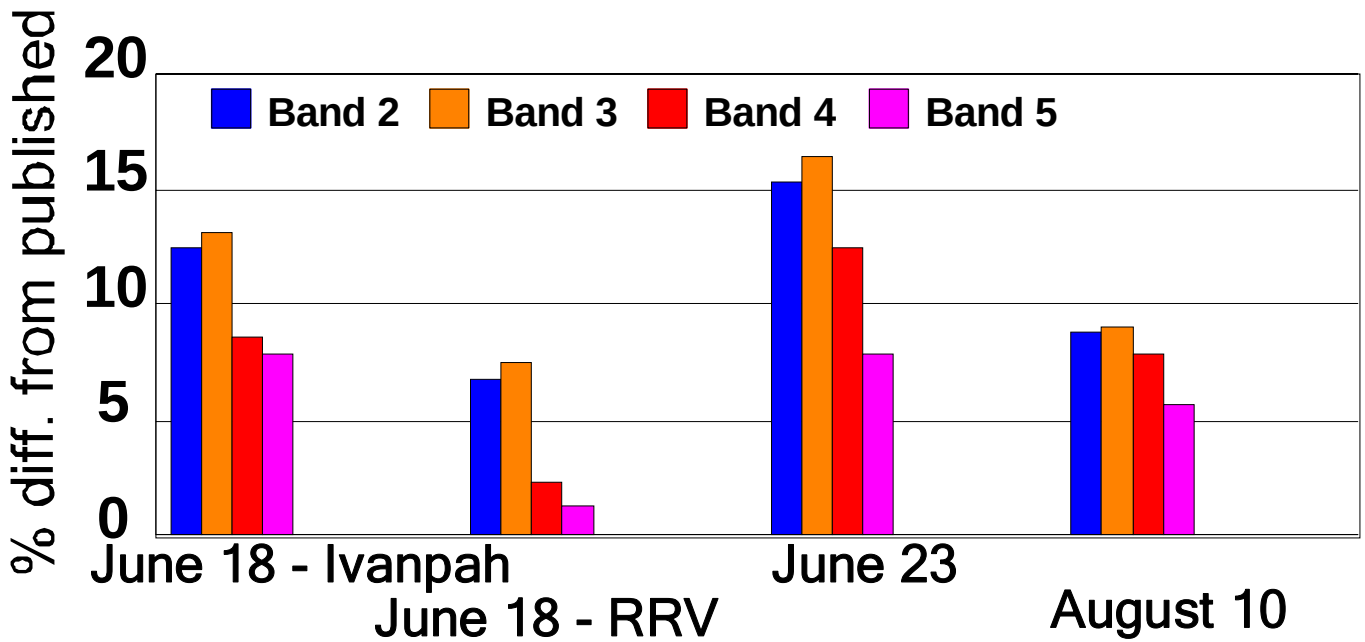
- Computed reflectance from LED radiometers for both June 17 and 18
- Compute percent difference between days by band
- Scale the June 17 hyperspectral reflectance by the average percent difference



Results

Graph below shows results from all three dates including the automated results

- Results below show the percent difference between the predicted radiance and that based on supplied calibration
- Positive percent difference implies that the predicted radiance is greater than the reported

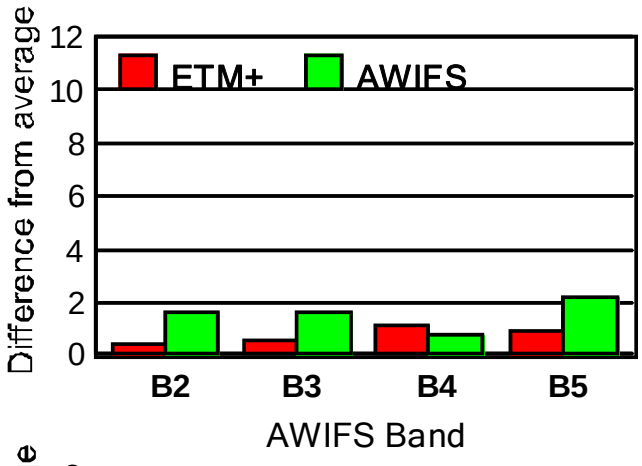


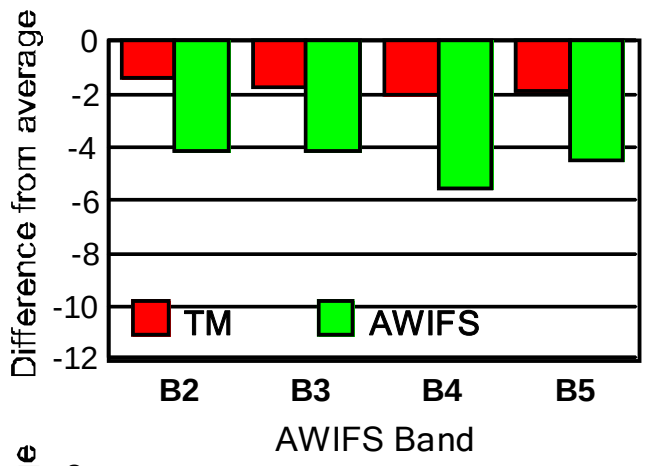
Confidence Level

Examine the AWIFS results relative to results from other sensors near in time

- Results show the difference between average for a given sensor and the results for a given date

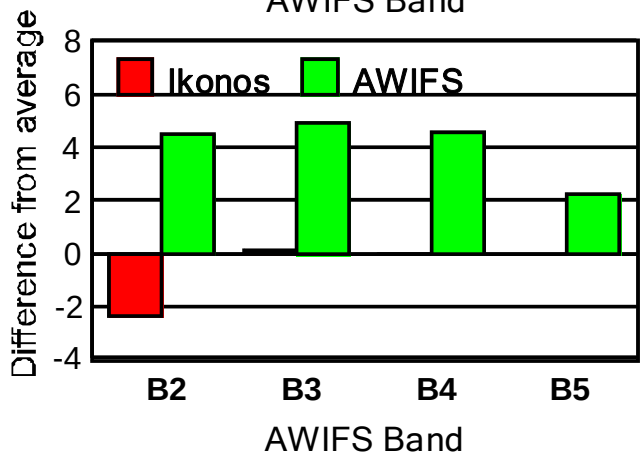
June 18
Ivanpah

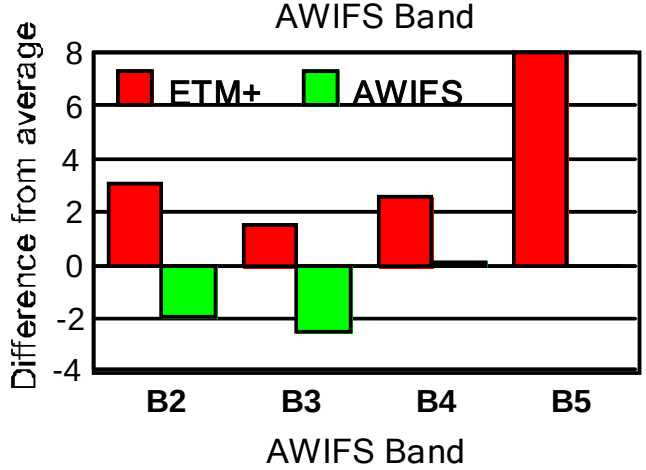




June 18
RRV

June 23





Aug. 10

Summary

Standard deviation of the average is similar to that for other sensors giving confidence to results

- Results are slightly better without LED results
  - 1.3 to 3.7% standard deviations (for three data sets)
  - Other sensor results typically show <3%
  - Implies self consistency within the data set
- Previous graph also implies that AWIFS results are of similar absolute uncertainty as for other sensors (<3% in VNIR)