Radiance Calibration of MODIS and MISR in the visible and near infrared

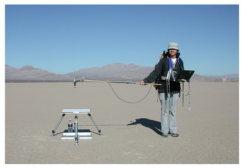
Stuart F. Biggar
Remote Sensing Group, Optical Sciences Center
University of Arizona

Our group at the University of Arizona has been using a reflectance-based method for vicarious calibration of MODIS and MISR and other optical sensors such as ETM+, ALI, ASTER, Hyperion, MASTER, and MAS. We have also used a radiance-based method in the past for SPOT and TM. We normally work at sites such as Railroad Valley, NV, Ivanpah Playa, CA, and White Sands Missile Range, NM. We have compared many sensors using the reflectance-based method.

Reflectance-based Method

Measure ground reflectance with spectralon panel and ASD

Measure atomospheric extinction with solar radiometer
- Partition extinction into aerosol, molecular, and absorbtion
- Invert aerosol extinction to get estimated aerosol size distribution



Measuring ground reflectance by reference to spectralon

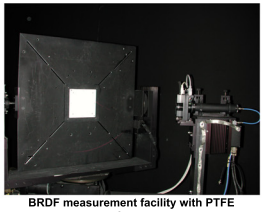
Compute top-of-atmosphere radiance using radiative transfer code (RTC)

Refinements
- Instrumentation
- BRDF measurement

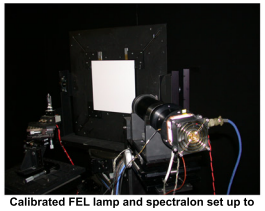
All sky photograph of a "good" day for calibration at Ivanpah

Laboratory to support field work

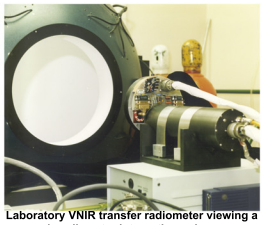
Calibrated sources of spectral irradiance (NIST FEL Lamps)
Calibrated spectralon diffuser (NIST measurement)
Calibrated sources of spectral radiance (integrating sphere and lamp+diffuser)
BRDF measurement facility
Calibrated transfer radiometers (selected MODIS/ASTER/MISR bands)



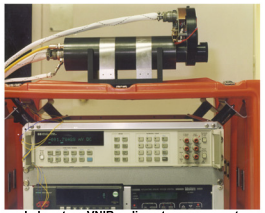
BRDF measurement facility with PTFE reference



Calibrated FEL lamp and spectralon set up to calibrate a simple radiometer (ROLO monitor)



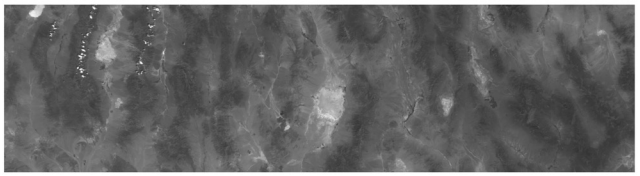
Laboratory VNIR transfer radiometer viewing a 1-m diameter integrating sphere



Laboratory VNIR radiometer on support electronics crate

Current Work

1. Continue developement of a radiance-controlled, adjustable output, integrating sphere for use in the calibration laboratoy. This radiance source will have monitor diodes independent of the radiance control diode.
2. Refine calibration of the portable VNIR radiometer and use in the field during sensor calibrations to provide an independent check of the reflectance-based method.
3. Evalulate our reflectance measurement accuracy with new NIST calibrated lamp and spectralon panel.
4. Provide reflectance-based calibrations of MODIS and MISR and other sensors such as ETM+ and ASTER.



MISR image of Railroad Valley playa in Nevada

Radiance-based Method

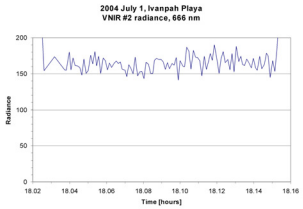
Measure radiance with well calibrated radiometer
- Just above ground level
- At altitude in an aircraft

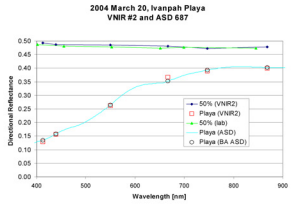
Use RTC (and reflectance-based data) to correct to TOA radiance

We have built a rugged, portable version of the VNIR transfer radiometer

It is well characterized and calibrated with a NIST FEL lamp and Spectralon

Preliminary field testing in 2004 at Ivanpah Playa





Note the small offset in the blue measured reflectance between ASD and the VNIR radiometer. There is also a difference at 666 nm.

We have noted a possible bias in reflectance based calibration in the blue for sensors such as ETM+. We have also noted differences between ASD instruments at about 650 nm.

We are investigating this possible bias using the VNIR radiometer as it is well calibrated and stable as compared to the portable ASD spectrometer.

We will also calibrate the portable VNIR radiometer using the sun and a solar radiometer. An example experiment with a laboratory SWIR transfer radiometer is shown below. We use the direct solar illumination corrected for extinction along the path to the sun. This will provide an independent calibration, especially when used with solar irradiance values when available from SORCE.

Parasol shaded SWIR measurements (to measure diffuse component)

SWIR radiometer viewing sunlit spectralon (both direct and diffuse illumination)