Emerging Techniques for Vicarious Calibration of Visible Through Short Wave Infrared Remote Sensing Systems

Authors: Robert E. Ryan, Gary Harrington, Kara Holekamp, Mary Pagnutti, Jeffrey Russell, Troy Frisbie, Thomas Stanley

Themes:
- Typical Radiometric Vicarious Calibration
- Radiative Transfer Validation
- Shadowed Sun Photometer Measurements
- Calibration and Characterization of ASD FieldSpec Spectroradiometers
- Test Case Evaluations
- Alternative Sun Photometer Implementation
- Desired In-Field Radiometric Calibration Source

Background
- The scientific community needs georeferenced and radiometrically accurate products from the present and future "constellation" of spaceborne and airborne systems.
- Typical radiometric vicarious calibration systems will be limited in many cases.
- Most systems will not have any onboard radiometric calibration.
- Cal/Val vicarious calibration is essential.
- Ground-based radiometric calibrations currently require teams of trained staff taking coincident data at the time of overpass and analyzing.
- MODTRAN verification.

Issues
- Ground-based radiometric calibration needs.
- Near-term needs: increased confidence in independent validation of ground truth and modeling.
- Mid-term needs: development of techniques that are compatible with autonomous measurements.
- Long-term needs: fully autonomous vicarious calibration techniques and sites.

SSC Near-Term Cal/Val Development Goals
- Improved accuracy and higher confidence in TOA radiance estimates.
- Radiative transfer modeling validation.
- Alternative sun photometer calibration and validation.
- Calibration and characterization of ASD FieldSpec Spectroradiometers.

Calibration and Characterization of ASD FieldSpec Spectroradiometers
- NASA-SSC maintains four ASD FieldSpec FR spectroradiometers.
- Laboratory transfer radiometers.
- Surface reflectance for SWIR field collection activities.
- Radiometric Calibration.
- NIST-calibrated integrating sphere as source with known spectral radiance.
- Solar Transmittance.
- Laser and pen lamp illuminating of integrating sphere.
- Environmental Testing.
- Temperature-stability tests performed in environmental chamber.

Test Case Evaluations
- TOA radiance values for selected targets on two days.
- Radiance values generated with alternative sun photometer optical geometry are compared to TOA values generated with the traditional method.

Differences in TOA radiance between the two methods are negligibly small.

Alternative Sun Photometer Implementation
- Speckle can be considered an infinite-diameter point source in the spectroradiometer is radially collimated.
- Knowing the reflectance factor of a function of zenith angle and azimuth angle.
- Diffuse-to-global ratio (CDG) used to determine molecular scattering.

Test Case Evaluations
- TOA radiance values for selected targets on two days.
- Radiance values generated with alternative sun photometer optical geometry are compared to TOA values generated with the traditional method.

Differences in TOA radiance between the two methods are negligibly small.

Summary
- Autonomous visible to SWIR ground-based vicarious cal/val will be an essential Cal/Val component with such a large number of systems.
- Rapidly calibrated spectroradiometers can improve confidence in current ground-truth data.
- Vicarious calibration.
- Validation or replacement of traditional sun photometer measurements.
- Should enable significant reduction in deployed equipment such as equipment used in traditional sun photometer approaches.
- Simple, field-portable, while light LED calibration source promises for visible range (400-700 nm).
- Prototype demonstrates +0.5% drift over 8-10°C temperature range.
- Field-ready light LED calibration source must be able to produce visible range (400-700 nm) signal.
- Enabling technology for developing autonomous sites.

LDI-based Radiance Source
- Explode recent developments in high-power LED sources.
- Utilize integrating sphere to create uniform light field.
- Use high-light stabilization to achieve radiometric stability.
- Test and calibrate system with environmental chamber and independent spectrometer.

LED-based Radiance Source Characteristics
- Temperature-stable white light LED.
- Spectral range 450-750 nm.
- Other LEDs would increase the spectral range.
- Temperature-stable phosphor and feedback loop-stabilized integrating sphere with radiance level.
- Short-term drift < 0.2%.
- Short-term drift < 0.5% over temperature range 10-40°C and over large spectrally.

Comparison of LED Integrating Sphere with Traditional Sources
- MODTRAN calibration tools for 30 degrees solar zenith, radiometrically accurate, 25 km visibility and rural aerosol.
- TOA radiance levels calculated for 30% reflectance targets and 1 m above Spectralon panel.
- Sun photometer panel with 2300 K.

Stennis Verification & Validation (V&V) Site
- Science Systems and Applications Inc., SSC
- Computer Sciences Corporation, SSC
- Applied Research & Technology Project Office, NASA, SSC

POC: Robert E. Ryan, rryan@ssc.nasa.gov; Mary Pagnutti, mpagnutti@ssc.nasa.gov

LED-based radiometric calibration source with phosphor stripdown.

End of page