Radiometric calibration and atmospheric correction

David R. Thompson\textsuperscript{1}
Bo-Cai Gao\textsuperscript{2}
Robert O. Green\textsuperscript{1}

\textsuperscript{1} Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA
\textsuperscript{2} Naval Research Laboratory, Washington, DC

Copyright 2015 California Institute of Technology. All Rights Reserved.
US Government Support Acknowledged.
Part 1: Radiometric Calibration

Part 2: Atmospheric Correction

NASA/JPL Portable Remote Imaging Spectrometer (PRISM)
A motivating example from PRISM

In-situ data courtesy Raphe Kudela, UCSC

Two issues…

- UV falloff
- Spikes?

$R_{rs}$

Wavelength (microns)

$10^{-3}$
Part 1: Radiometric calibration
Find zero
Remove dark current levels
Remove electronic effects
Apply flat field
Apply radiometric calibration
Translate to Radiance

Radiometric Calibration

NASA/JPL Portable Remote Imaging Spectrometer (PRISM)
Calibration challenges: radiometry

![Graph showing typical red-rich calibration source](image-url)
Spectral response affects the estimated radiometry.
Part 2: Atmospheric correction
Surface reflectance retrieval

Solar spectrum $F$ (Kurucz)

Top of atmosphere apparent reflectance $\rho$

$$\rho = \frac{\pi L}{F \cos(\theta)}$$

Retrieve pressure altitude, $H_2O$ vapor, liquid by fitting absorption features

Gaseous transmission $T_g$

Aerosol particle type distribution
AOD at 550nm

6s radiative transfer code calculates molecular & aerosol scattering

Aerosol transmission $T_d T_u$
Spherical sky albedo $s$
Path reflectance $r_a$

Water-leaving reflectance spectrum

$$r_s = \frac{\rho/T_g - r_a}{T_d T_u + s(\rho/T_g - r_a)}$$
PRISM sampling

\( T_{NO2} \)  Gas absorption terms

\( T_{O3} \)

\( T_u T_d \)

Transmittance due to scattering

Irradiance

\( r_a \)  Path reflectance

Spherical albedo

Irradiance W/m²/µm

Wavelength (micron)
Optimizing irradiance estimates

- Hypothesis: fine spectral sampling (~3nm) causes sensitivity to sampling of the solar irradiance (and intrinsic uncertainty)

- Solution: modify an irradiance estimate using a smooth in-scene reference (here, a concrete surface)
Optimizing irradiance estimates

\[ E(x) = kf (R_{rs}) - \hat{R}_{rs}(x)k_2 + \beta kx - 1k_2 \]

Penalize difference vs. smoothed reflectance

Penalize large perturbations

Levenberg Marquardt

![Graph showing irradiance estimates across different wavelengths with various spectral curves and annotations for SAO2010, Thuillier 2004, Fontenla, ATREM standard, and Optimized.]
Agreement with *in situ* $R_{rs}$ is improved

Aerosols are a persistent challenge

In-situ data courtesy Sherry Palacios and Liane Guild, NASA Ames; Raphe Kudela, UCSC
Concluding thoughts

• Ocean observations place extreme requirements on both calibration and atmospheric correction

• Is there a common root cause to both issues (far tails of the SRF)?

• Underlines need for spectral uniformity
Thanks

• The PRISM team, including Zakos Mouroulis, Byron Van Gorp, Mark Helmlinger, Scott Nolte, Sarah Lundeen

• Felix Seidel, Heidi Dierssen, Michelle Gierach, John Fontenla, Raphe Kudela,