Radiometric calibration and atmospheric correction

David R. Thompson¹
Bo-Cai Gao²
Robert O. Green¹

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

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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} vs. Wavelength (microns)

0.4 0.45 0.5 0.55 0.6 0.65

0.002 0.004 0.006 0.008 0.01

x 10^{-3}

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david.r.thompson@jpl.nasa.gov
Part 1: Radiometric calibration
Radiometric Calibration

- Find zero
- Remove dark current levels
- Remove electronic effects
- Apply flat field
- Apply radiometric calibration
- Translate to Radiance

Raw DNs

Radiance (W/nm/sr/cm²)

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

Typical red-rich calibration source
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 $T_g$

- Water-leaving reflectance spectrum
  \[ r_s = \frac{\rho/T_g - r_a}{T_d T_u + s(\rho/T_g - r_a)} \]

- 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 $r_a$
Gas absorption terms

Path reflectance

Spherical albedo

Transmittance due to scattering
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

$$E(x) = k_f \Box (R_{rs}) - \hat{R}_{rs}(x)k_2 + \beta kx - 1k_2$$

Penalize difference vs. smoothed reflectance

Penalize large perturbations

Levenberg Marquardt

Optimized

SAO2010
Thuillier 2004
Fontenla
ATREM standard
Agreement with *in situ* $R_{rs}$ is improved

M0 Buoy, $R_{rs}$ retrieval using different solar irradiance spectra

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)?
• Underscores need for spectral uniformity
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