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Radiometric calibration and atmospheric correction

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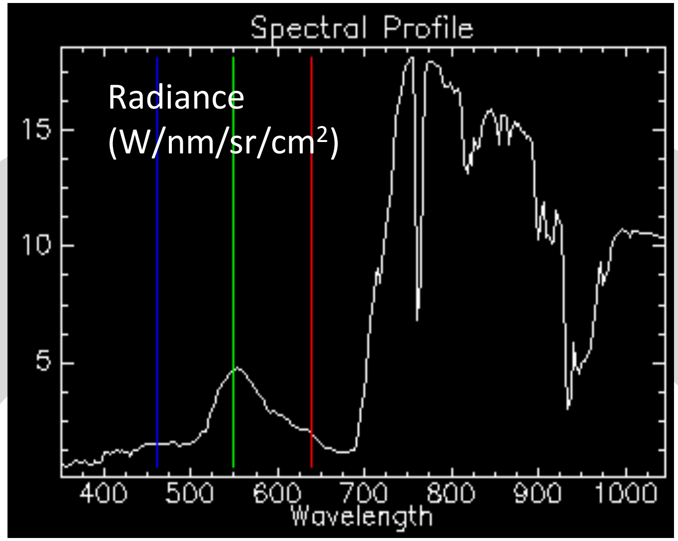
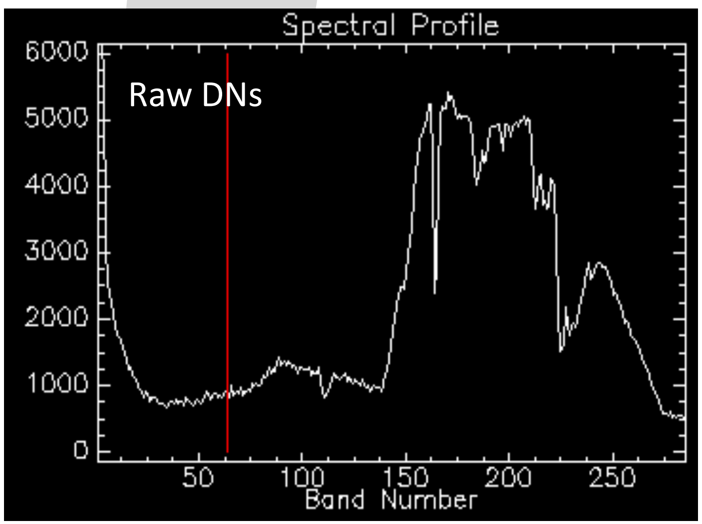
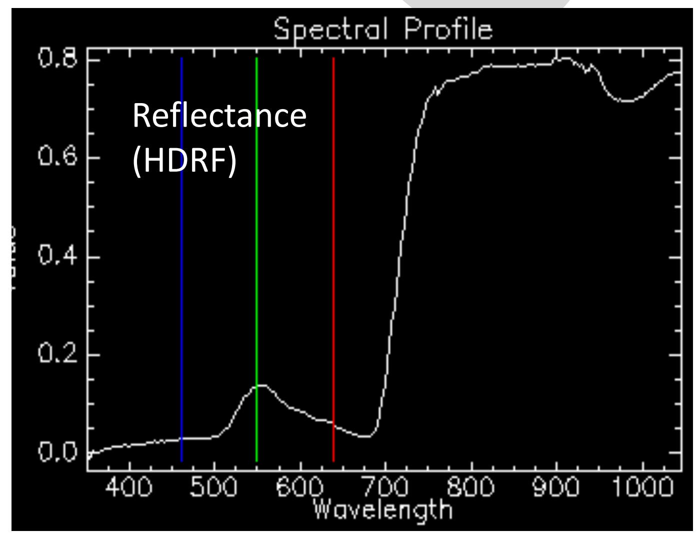
Part 1: Radiometric Calibration

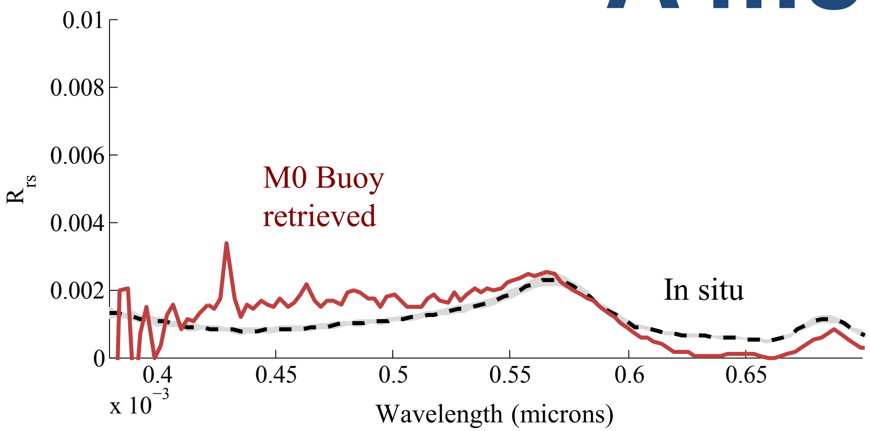


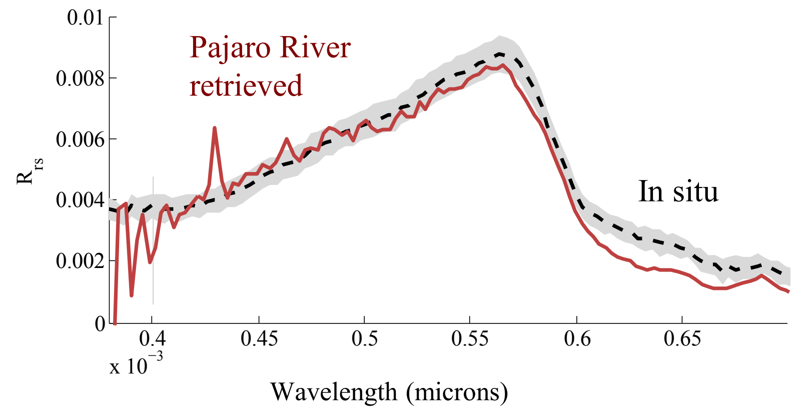
Part 2: Atmospheric Correction

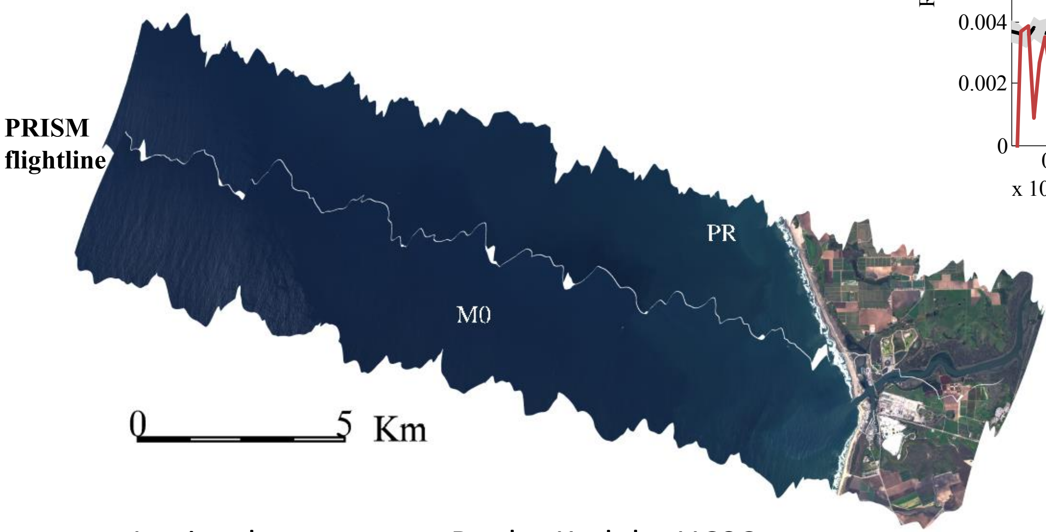




A motivating example from PRISM



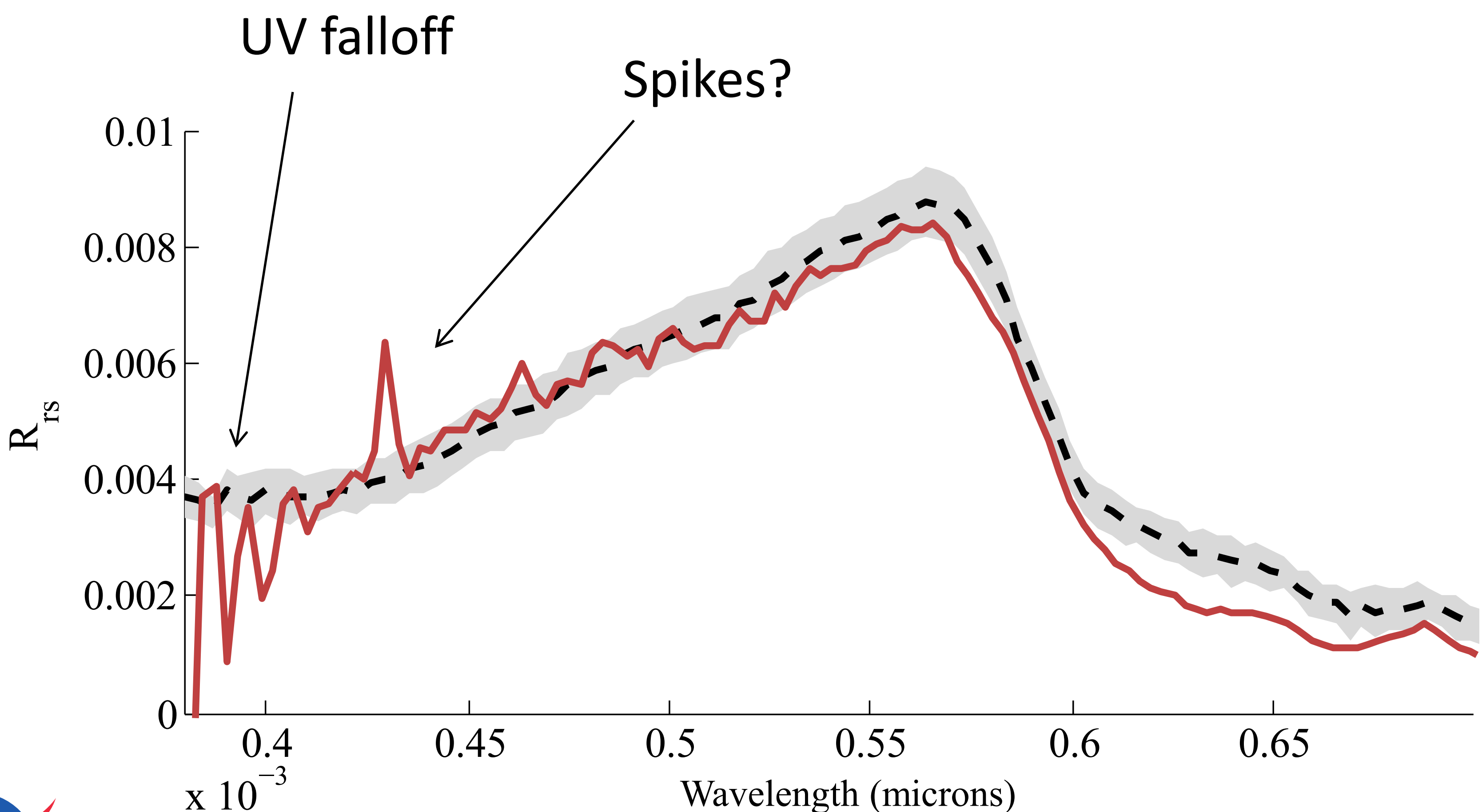




In-situ data courtesy Raphe Kudela, UCSC

D. R. Thompson, F. Siedel, B.-C. Gao, M. Gierach, R. Kudela, R. O. Green, P. Mouroulis. Optimizing Solar Irradiance for Coastal Spectroscopy. *Geophysical Research Letters* (2015, in press).

Two issues…



UV falloff
Spikes?
0.01
0.008
0.006
0.004
0.002
0
R_{rs}
0.4
0.45
0.5
0.55
0.6
0.65
x 10^{-3}
Wavelength (microns)

Part 1: Radiometric calibration

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Radiometric Calibration

Find zero

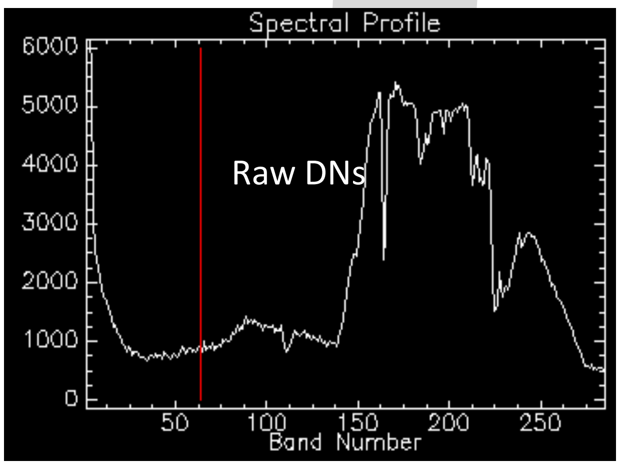
Remove dark current levels

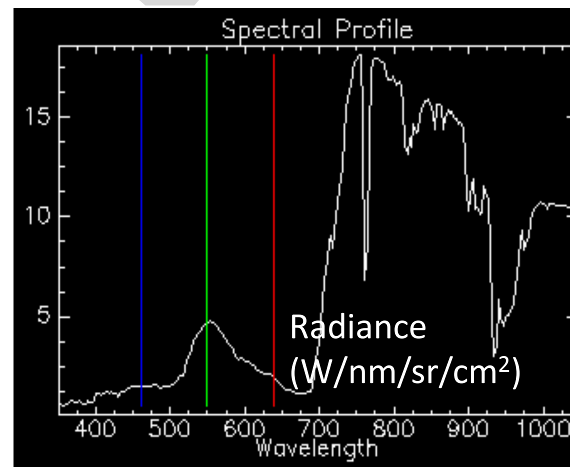
Remove electronic effects

Apply flat field

Apply radiometric calibration

Translate to Radiance





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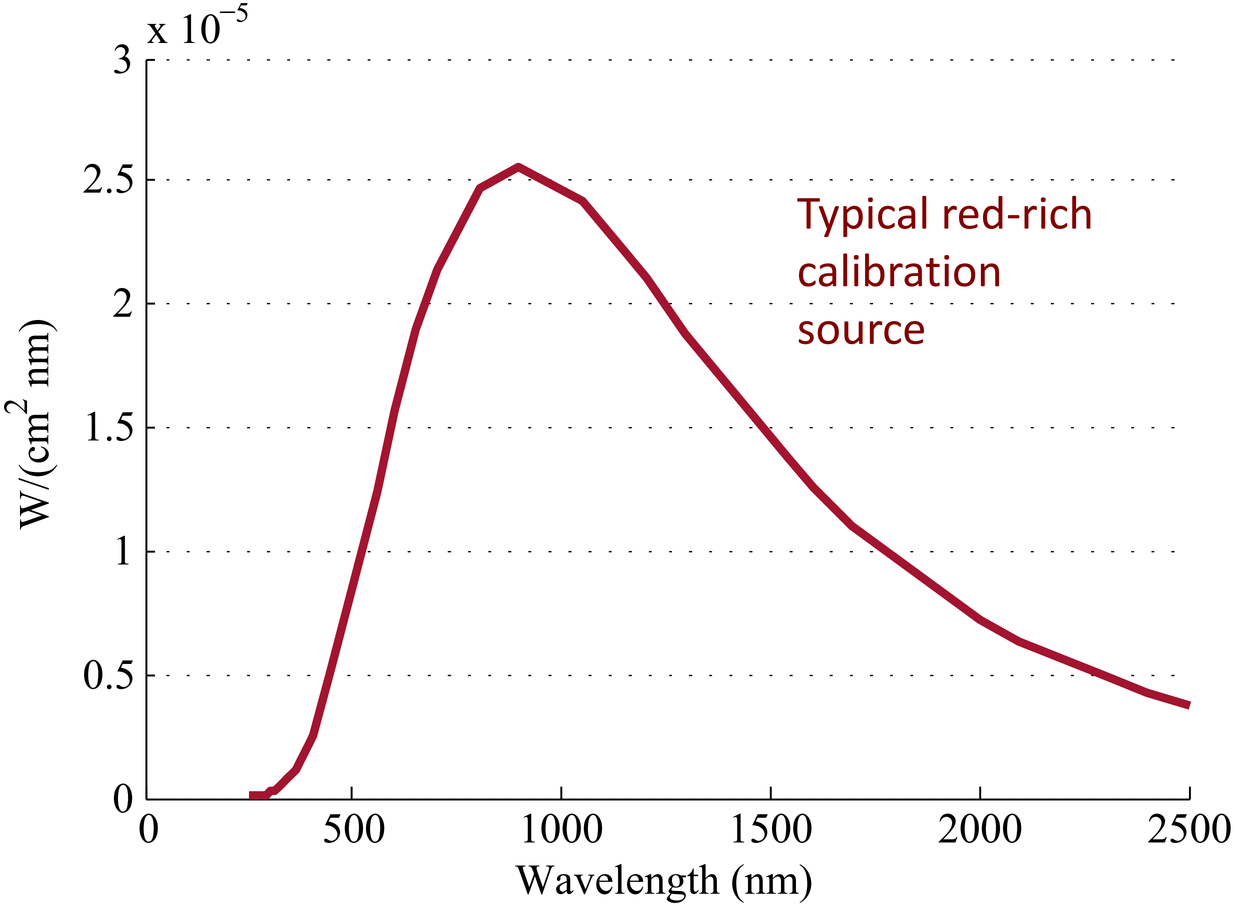
Calibration challenges: radiometry



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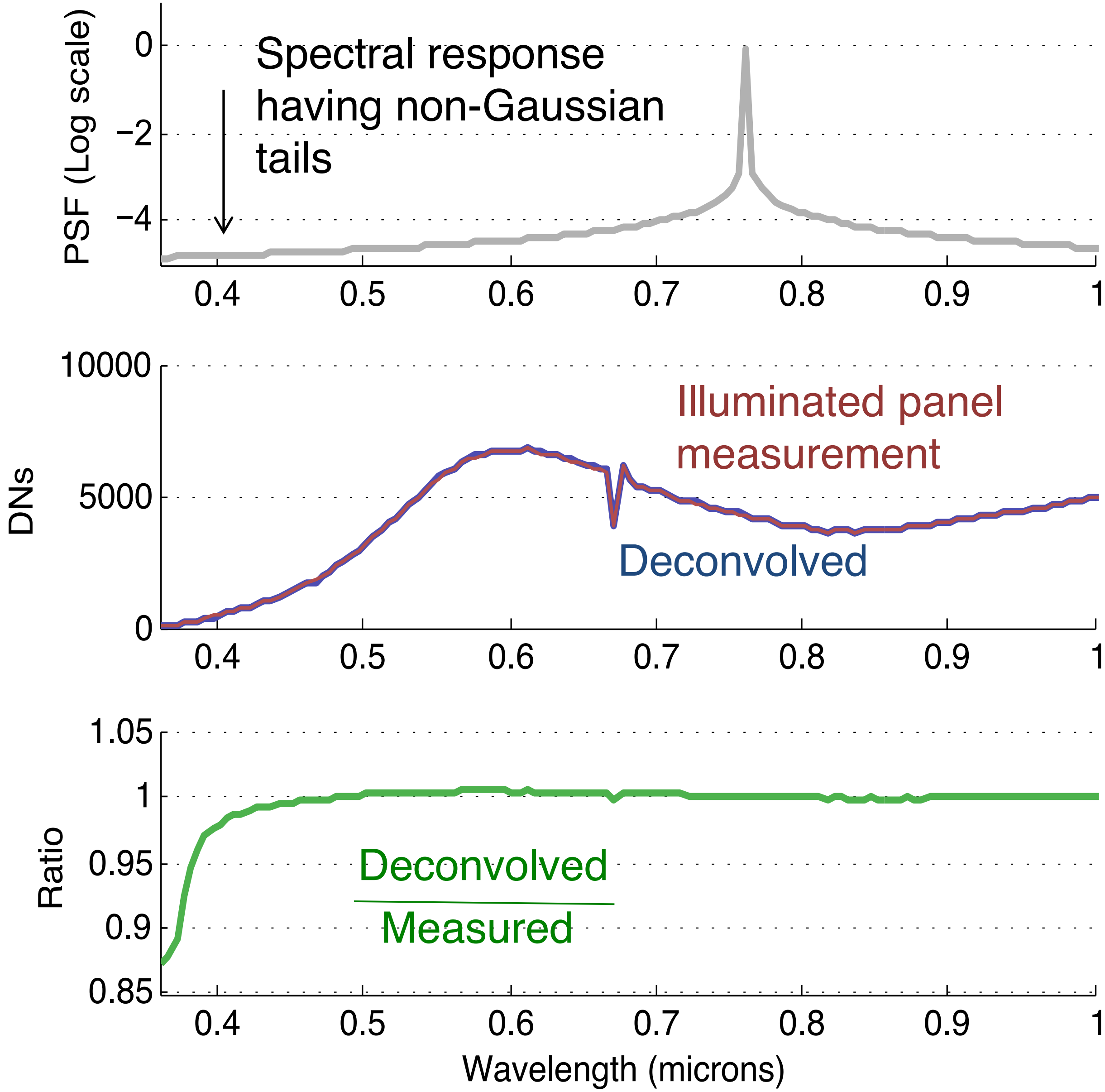
Spectral response affects the estimated radiometry



Part 2: Atmospheric correction

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Surface reflectance retrieval

Solar spectrum F
(Kurucz)

Top of atmosphere apparent reflectance ρ

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

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

Gaseous transmission T_g

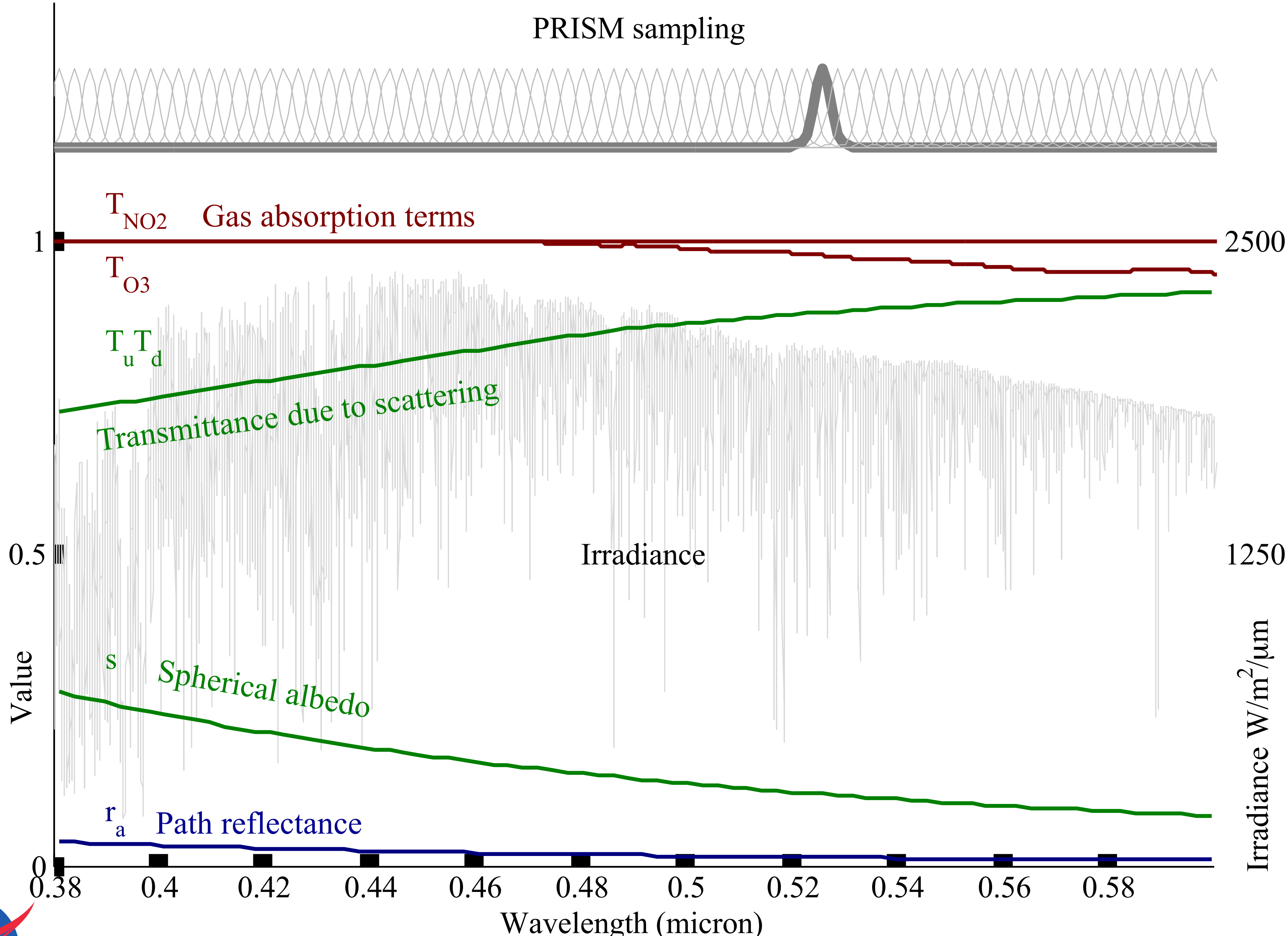
Aerosol particle type distribution
AOD at 550nm

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

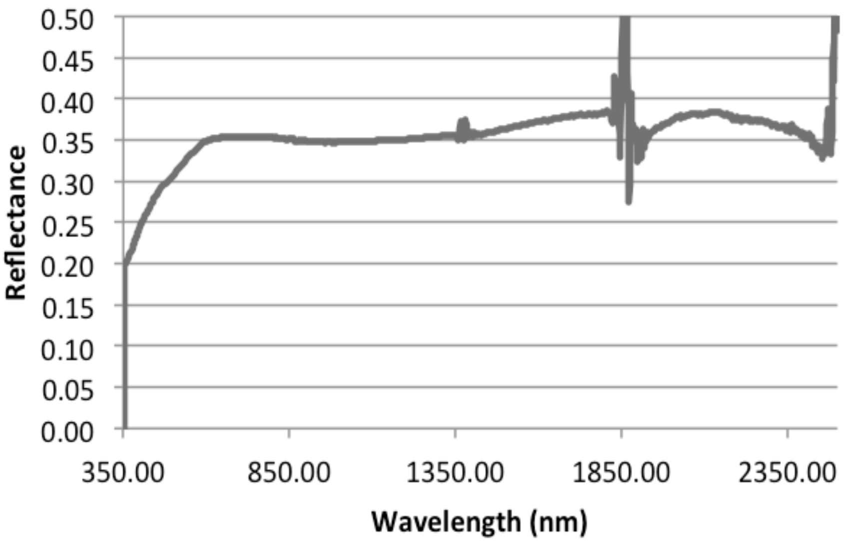
$$r_s = \frac{\rho/T_g - r_a}{T_d T_u + s(\rho/T_g - r_a)}$$


PRISM sampling
T_{NO2} Gas absorption terms
T_{O3}
$T_u T_d$
Transmittance due to scattering
Irradiance
s Spherical albedo
r_a Path reflectance
Value
Irradiance W/m^2/µm
1
0.5
0
2500
1250
0.38
0.4
0.42
0.44
0.46
0.48
0.5
0.52
0.54
0.56
0.58
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)



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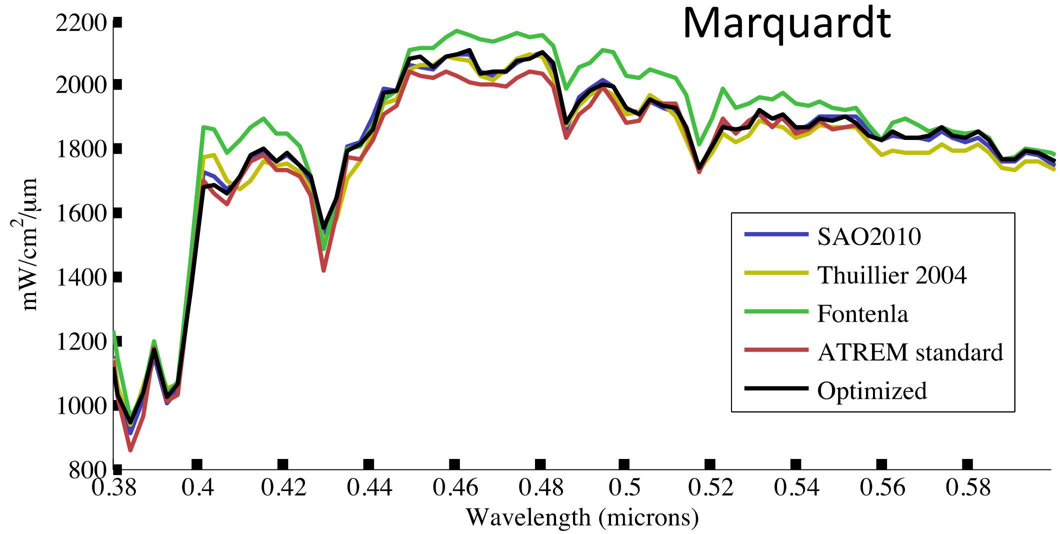
Optimizing irradiance estimates

$$E(x) = \underbrace{\| f_{\square}(R_{rs}) - \hat{R}_{rs}(x) \|_2}_{\text{Penalize difference vs. smoothed reflectance}} + \underbrace{\beta \| x - 1 \|_2}_{\text{Penalize large perturbations}}$$

Levenberg Marquardt



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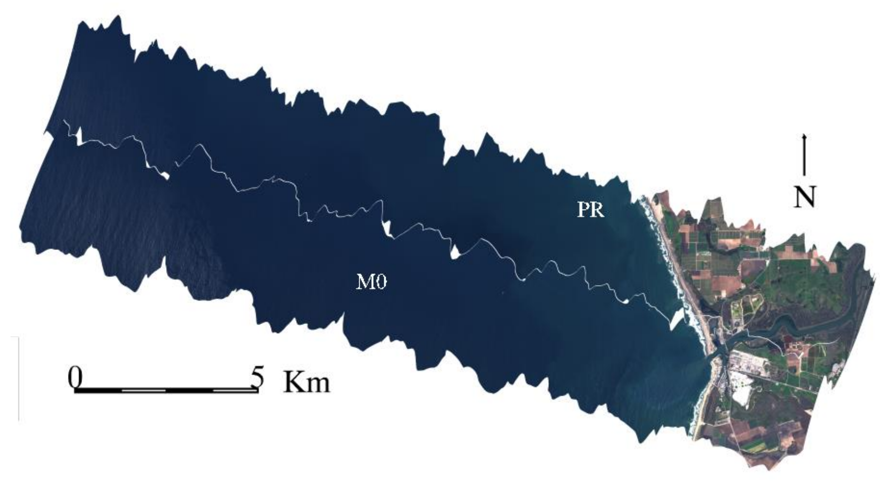
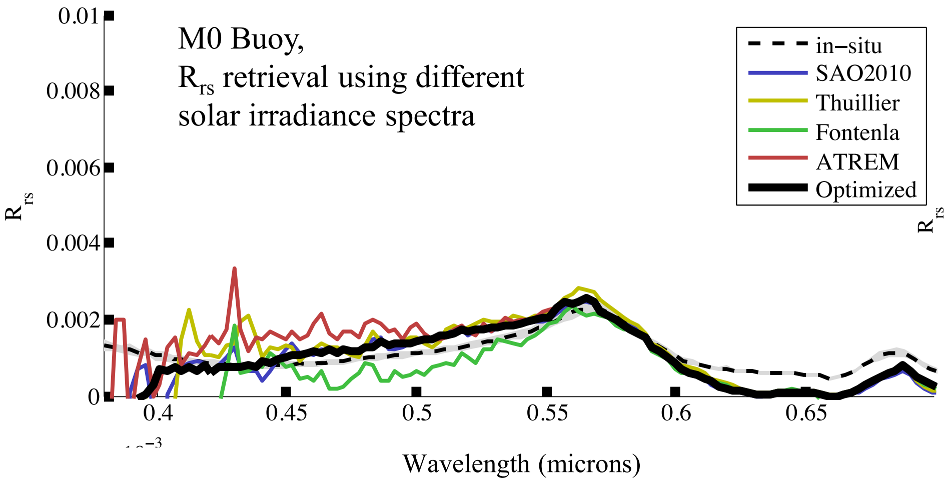
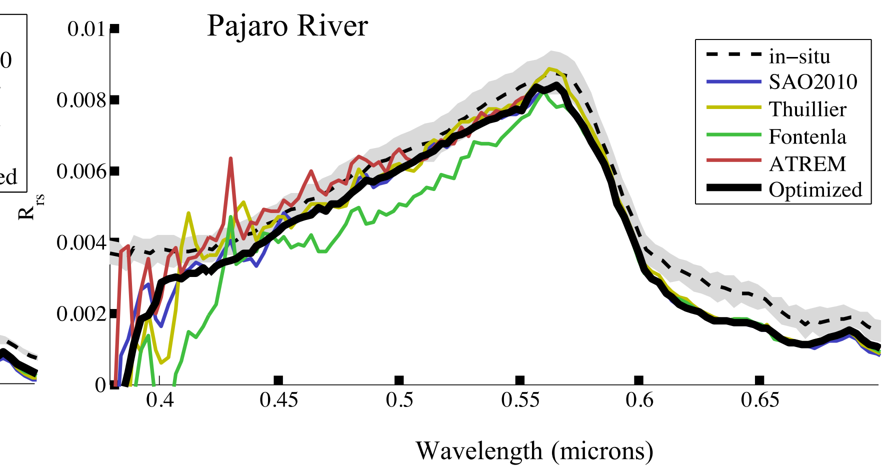
Agreement with *in situ* R_{rs} is improved







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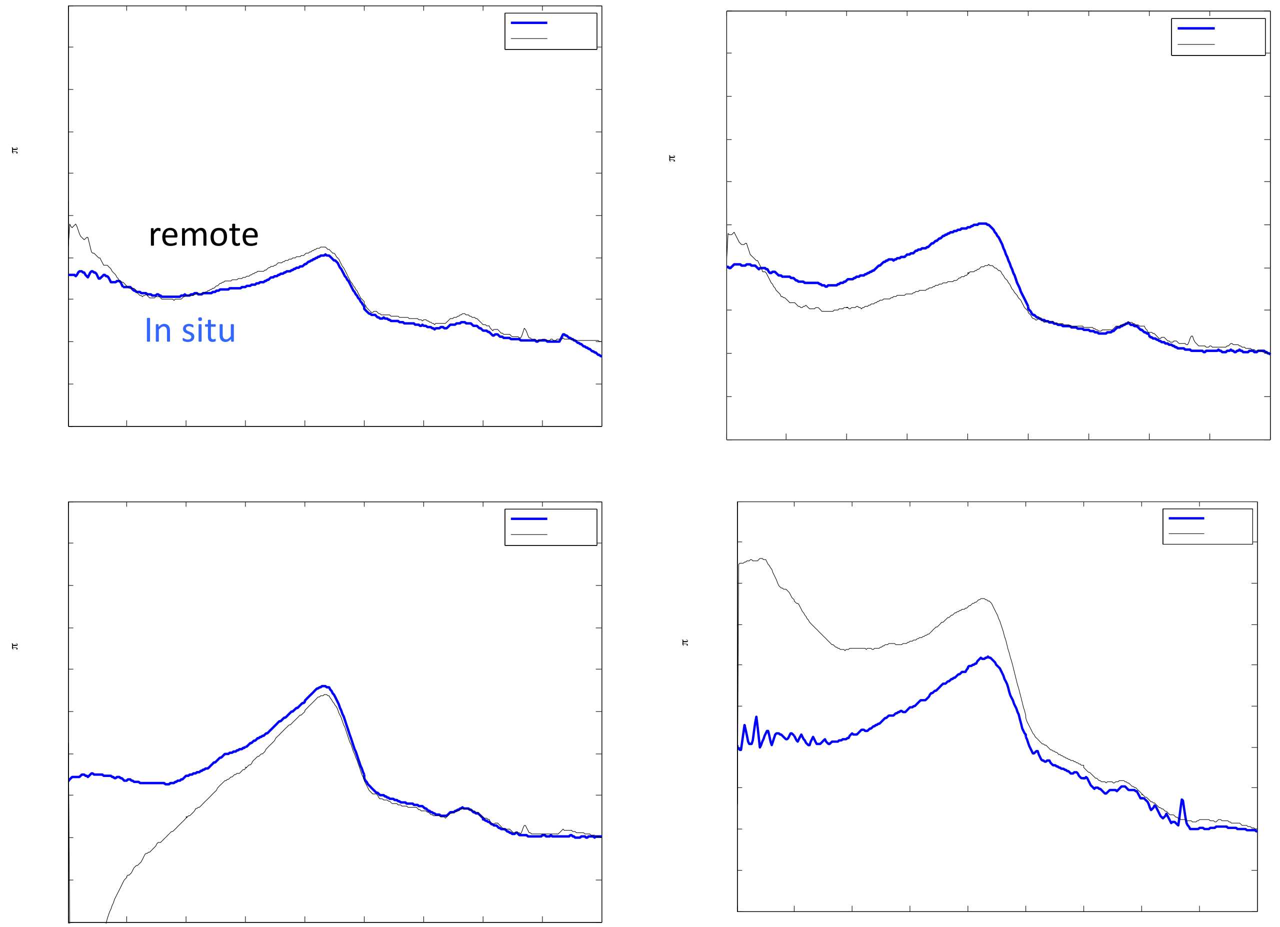
Aerosols are a persistent challenge



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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Thanks

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