The HyspIRI Preparatory Campaign
VSWIR Level 1 and Level 2 Products

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Agenda

• AVIRIS Product Definition and Algorithm Theoretical Basis
• Overview of the VSWIR HyspIRI simulated data
AVIRIS radiance / reflectance pipeline

Lambertian Reflectance (HDRF)

Radiance at sensor mW/nm/cm²/sr

Raw Digital Numbers

[Gao et al., 1993; Green et al., 1998]
L1 Radiance calibration

- Based on Laboratory calibration standards
- Minor radiometric correction in UV based on clouds (which are assumed smooth)

Assumed reflectance

Retrieved reflectance

Courtesy Bo Cai Gao
Typical vegetation spectrum

After

Before

Courtesy Bo Cai Gao
Solar spectrum $F$ (modified Kurucz)

Top of atmosphere apparent reflectance $\rho$

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

Retrieve pressure altitude, H$_2$O vapor, liquid by fitting absorption features

Aerosol particle type distribution, AOD at 550nm

Calculate molecular & aerosol scattering w/6s radiative transfer code

Gaseous transmission $T_g$

Aerosol transmission $T_dT_u$

Spherical sky albedo $s$,
Path reflectance $r_a$

Reflectance spectrum

$\rho / T_g - r_a$

Residual suppression based on a reference target

Corrected reflectance spectrum

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L2 Surface reflectance
Typical transmittance

Absorption is modeled for 7 gases

ATREM retrieves water vapor for each pixel using 0.94 and 1.14 μm H₂O band depths

Vertical profiles use 20-layer atmospheres

[Gao and Green 2010]
Reducing bias in H$_2$O vapor maps


Pressure Altitude Retrieval

Pressure Altitude LUT

TOA Reflectance → O$_2$ A Band Ratio

H$_2$O Band Ratio

Nonnegative Least Squares

Path Lengths

H$_2$O Retrieval

Linearized fit

Model

Observed

TOA Reflectance

Wavelength (nm)

Transmittance

% Residual (model−measured)

Wavelength

Liquid

Vapor

Better H$_2$O Vapor Maps

From Pennington et al., AGU 2015
Residual suppression

- Multiplicative correction
- Derived from a smooth surface once per flight season
- Reversible using coefficients stored in metadata
Ground truth validation targets

- Dark targets too bright, bright targets too dark
- This suggests uncorrected scattering is a major offender
- Accuracy degrades somewhat at short wavelengths
- Water vapor maps (not shown) still show some “vegetation bias”

![Graphs showing reflectance vs wavelength for different targets.](image)

**Courtesy Dar Roberts from Thompson et al., RSE 2015 (in press)**
Agenda

• Product Definition and Algorithm Theoretical Basis

• Overview of the HyspIRI simulated data
HyspIRI simulation objective

• Create orthorectified reflectance data with similar spatial and noise characteristics to the HyspIRI VSWIR
• Demonstrate processing pipeline that is scalable to anticipated HyspIRI data rates
• Demonstrate L2 algorithms operating across large, diverse geographic areas
HyspIRI simulated data products

Products:
- 18m, 30m, 60m obs
- 18m, 30m, 60m radiance
- 18m, 30m, 60m optical paths for H₂O
- 18m, 30m, 60m reflectance

AVIRIS Calibrated Radiance 677 pixel swath

x,y,z coordinates of pixel centers (Boardman)

18m nearest neighbor resampling

30m Gaussian resampling

60m Gaussian resampling

HyspIRI NEdL added

HyspIRI NEdL added

ATREM

ATREM

ATREM


Courtesy Phil Dennison
Data access instructions: