HyspIRI-TIR
Cal/Val Approach

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TIR Concept

Blackbody (V-Groove)

Space View

Earth View
Calibration Overview

- Spectral Calibration
- Radiometric Calibration
- Spatial Calibration
- On-Orbit Calibration
Spectral Calibration with Monochromator

- Heritage (JPL) – PMIRR, TES, MCS, Diviner
- Straightforward approach with reliable results.
- Only a small number of pixels are measured at once. Very time intensive to measure all pixels over full spectral range.
Radiometric Calibration

• Performed in vacuum to prevent condensation on cold blackbody surfaces.
• Scan mirror rotates to scan between internal blackbody, cold blackbody, and variable temperature blackbody.
• Variable temperature blackbody is stepped over entire scene temperature range.
• System nonlinearities can be determined using measured spectral response and blackbody response.
• NETD determined by temperature response and noise level.
Spatial (FOV) Calibration

For cross-scan FOV measurements (slit out of page), TIR scan mirror will sweep slit across focal plane.

For along-scan FOV measurements (slit vertical on page), slit will be scanned in perpendicular direction (perpendicular to page) to map out focal-plane FOV.
Validation Framework

• Multi-Component Approach
• Monitoring of instrument outputs (BB performance etc)
• Cross comparison of HyspIRI radiance with other instruments (airborne and spaceborne, emphasize HyTES)
• Validation against in situ targets (Tahoe and Salton Sea)
On-Orbit CalVal

Lunar View 1 per month {radiometric}
Blackbody Views 1 per scan {radiometric}
Deep Space Views 1 per scan {radiometric}
Surface Cal Experiments 2 (d/n) every 5 days {radiometric}
Spectral Surface Cal Experiments 1 per year

- Two-point calibration, using space and an ambient temperature blackbody, will be performed every 2.1 seconds.
- Detector specs limit 1/f noise over 2.1 second period. Optics/baffle design limits thermal drifts over 2.1 seconds.
- Data stream will include averaged values of space and blackbody readings for each pixel.
- Nonlinearities measured during ground calibration will be incorporated into calibration algorithm (performed on ground).
Site Layout and Measurement Stations
MODIS Terra Vicarious and OBC Thermal Infrared Derived Radiances at Lake Tahoe CY2000-2008, v4-5.x

- Band 28 (7.43 µm)
- Band 29 (8.53 µm)
- Band 30 (9.73 µm)
- Band 31 (11.01 µm)
- Band 32 (12.03 µm)
- Band 33 (13.37 µm)

Vicarious Radiance (W/m².µm.sr) vs. OBC Radiance (W/m².µm.sr)
MODIS Terra Vicarious and OBC Thermal Infrared Derived Radiances at Lake Tahoe CY2000-2008, v4-5.x

\[
y = 1.0084x - 0.0394 \\
R^2 = 0.9918
\]

\[
y = 1.0289x - 0.2031 \\
R^2 = 0.992
\]

\[
y = 1.0327x - 0.2347 \\
R^2 = 0.9891
\]
In previous presentations only showed nadir data (461 match ups as above) due to manual processing, now have more automated system allowing all clear data to be processed (5219 match ups)
Summary and Conclusions

• Pre-flight
  – Spectral calibration
  – Radiometric calibration
  – Spatial calibration

• In-flight
  – Radiometric: 2 point (blackbody and space view)
  – Radiometric: lunar
  – Radiometric: ground sites, e.g. L. Tahoe
Backup
Spectral Calibration with FTIR

FTIR (Conceptual) Assembly

TIR Instrument

Nadir Port

Telescope

Control System

He-Ne laser system

Reference Detector

Glowbar Source

Fold Mirror

Scan Mirror

Collimating Mirror

TIR Detector Signals
FTIR Spectral Calibration

Heritage:
- AIRS
- OCO

Advantages:
- All pixels and wavelengths measured simultaneously
- Automatic spectral calibration to Helium Neon laser standard wavelength (632.8nm)

Disadvantages:
- Requires stepping of FTS to be synchronized with sampling of TIR detectors, or cumbersome post analysis.
Calibration of Blackbody Source

• Cavity temperature will be determined using NIST-traceable sensors.
• NIST Thermal Infrared Transfer Radiometer (TXR) may be used to compare blackbody to NIST standard blackbody.
Low and high angle of incidences correspond to low and high viewing zeniths
Error increases with view angle. Most likely cause is change in emissivity with viewing zenith. Note increased path length in atmospheric correction was corrected.