AVIRIS-C and AVIRIS-NG VSWIR Status

Robert O. Green and the Team
AVIRIS-Classic
The Airborne Visible-Infrared Imaging Spectrometer (AVIRIS)

- Proposed 1983 and first flew in late 1986
- F/1 optics; Si, InGaAs, InSb detectors; 200 μm class detectors
- 87 μs integration time; ≥ 1 M electrons in 10 nm channels for bright targets
- 8700 spectra per second; > 100 Terabytes of data and products
- AVIRIS is mentioned in more than 850 refereed journal articles
- Flew the RIM Fire, CA on the 13th of September 2013 (28 consecutive years)
AVIRIS on the ER-2
Example AVIRIS Calibration Validation Experiment

Ivanpah Playa Calibration Site
Preliminary Results 3 May 2013 HyspIRI Preparatory Campaign

![Graph showing radiance vs. wavelength with two curves: one labeled "Modtran 5 In Situ Constrained" and the other "AVIRIS-C 130503r06".]
HyspIRI Preparatory Airborne Science

(Ecosystems, Seasonal, Climate, Coastal, Urban, Resources)

- 6 zones, 3 seasons, 2 years
- Objective: Advance HyspIRI Mission Science Readiness
  - Ecosystem composition, function, biochemistry, seasonality, structure, and modeling
  - Coastal ocean phytoplankton functional types, habitat
  - Urban land cover, temperature, transpiration
  - Surface energy balance
  - Atmospheric characterization and local methane sources
  - Surface geology, resources, soils, hazards
HyspIRI Airborne Campaign – First Flights March 29, 2013, Palmdale CA

AVIRIS image cube and Level 1a, 1b and 2 spectra. The reflectance spectra (L2) will be used to address the full range of science objectives including ecosystems and climate.
AVIRIS Files

The following types of files should be found:

PER FLIGHT LINE (i.e., occurs once per tar file/directory):
  *info general information about the flight line,
  *gain multiplication factors, radiance to 16-bit integer,
  *nav navigation data,
  *rcc radiometric calibration coefficients,
  *readme this file,
  *txt description of AVIRIS orthocorrection processing,
  *spc spectral calibration file.
  *rcc radiometric calibration coefficients,
  *glt geometric look up table file
  *glt.hdr geometric look up table file header
  *igm input geometry file
  *igm.hdr input geometry file header
  *eph the position data in a WGS-84/NAD83 UTM x,y,z coordinate system
  *lonlat_eph the position in WGS-84 longitude, latitude and elevation
  *obs raw spatial format of the observation and illumination conditions of the uncorrected AVIRIS data,
  *obs.hdr associated header
  *obs_ort rendered image using the *_ort_glt lookup table and matches the orthocorrected imagery,
  *obs_ort.hdr associated header
  *img orthocorrected, scaled radiance image
  *img.hdr orthocorrected, scaled radiance image file header

To list files (table-of-contents):
  tar tvf "tar file name,"

To extract files:
  tar xvf "tar file name" "extract file name,"

To get information about tar:
  man tar
AVIRIS-Next Generation
# AVIRIS-C Compared to AVIRIS-NG

<table>
<thead>
<tr>
<th>Category</th>
<th>AVIRIS-Next Generation</th>
<th>AVIRIS-Classic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SPECTRAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>380 to 2510 nm</td>
<td>380 to 2500 nm</td>
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<tr>
<td>Position</td>
<td>5 nm</td>
<td>10 nm</td>
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<tr>
<td>Response</td>
<td>1 to 1.5 X sampling</td>
<td>1 to 1.5 X sampling</td>
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<tr>
<td>Calibration</td>
<td>+/-0.1 nm</td>
<td>+/-0.1 nm</td>
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<tr>
<td><strong>RADIOMETRIC</strong></td>
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<tr>
<td>Range</td>
<td>0 to max Lambertian</td>
<td>0 to max Lambertian</td>
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<tr>
<td>Precision (SNR)</td>
<td>&gt;2000 @ 600 nm</td>
<td>&gt;1000 @ 600 nm</td>
</tr>
<tr>
<td></td>
<td>&gt;1000 @ 2200 nm</td>
<td>&gt;400 @ 2200 nm</td>
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<tr>
<td>Accuracy</td>
<td>95% (&lt;5% uncertainty)</td>
<td>90% (&lt;10% uncertainty)</td>
</tr>
<tr>
<td>Linearity</td>
<td>&gt;=99% characterization</td>
<td>&gt;=99% characterization</td>
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<tr>
<td><strong>SPATIAL</strong></td>
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</tr>
<tr>
<td>Range</td>
<td>34° field-of-view</td>
<td>34° field-of-view</td>
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<tr>
<td>Sampling</td>
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<td>1 milliradian</td>
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<tr>
<td>Response</td>
<td>1 to 1.5 X sampling</td>
<td>1 to 1.5 X sampling</td>
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<tr>
<td>Sample Distance</td>
<td>0.3 m to 20 m</td>
<td>4 m to 20 m</td>
</tr>
<tr>
<td>Geom Model</td>
<td>Full 3 Axes cosines</td>
<td>Full 3 Axes cosines</td>
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<tr>
<td><strong>UNIFORMITY</strong></td>
<td></td>
<td></td>
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<tr>
<td>Spectral Cross-Track</td>
<td>&gt;95% across FOV</td>
<td>&gt;98% across FOV</td>
</tr>
<tr>
<td>Spectral-IIFOV-Variation</td>
<td>&gt;95% Spectral Direction</td>
<td>&gt;98% Spectral Direction</td>
</tr>
</tbody>
</table>
2012 AVIRIS-Next Generation
Substrate removed MCT 380 to 2510 nm

Alignment Complete
>95% cross-track and IFOV uniformity

“Smile”

“Keystone”
High Spatial Resolution
Methane Plume Detection

AVIRIS-NG

Modeled Spectrum

Spectrum

Methane Plume
Level 2 Data Product Dry Atmosphere
AVIRIS-NG

Graphs showing signal (DN), L1b radiance (μW/cm²/nm/sr), and L2 reflectance for different land cover types:
- Grassland L1a
- Conifer L1a
- NPV L1a
- Paved L1a
- Broadleaf L1a
- Herbaceous L1a
- Soil L1a
- Grassland L1b
- Conifer L1b
- NPV L1b
- Paved L1b
- Broadleaf L1b
- Herbaceous L1b
- Soil L1b
- Grassland L2
- Conifer L2
- NPV L2
- Paved L2
- Broadleaf L2
- Herbaceous L2
- Soil L2

Wavelength range: 400 to 2500 nm
AVIRIS-NG and HyspIRI VSWIR Concept

- Two mirror telescope
- Offner spectrometer
- Uniform SiN slit (eBL)
- Convex grating (eBL)
- Alignment mounts
- Alignment process
- All aluminum telescope
- Full range detector
- Order sorting filter
- Uniformity requirements
- Vacuum operation
- 140 K operation
Summary

- Successful collection the first season of the HyspIRI preparatory airborne campaign

- A calibration/validation experiment was held on the 3rd of May

- Level 1a, 1b and L2 data are being loaded into the AVIRIS locator/download tool

- AVIRIS-NG has flown in 2013 for a methane experiment at testing of the new data capture system including cloud and compression testing

- The AVIRIS_NG detector is being upgraded now.

- AVIRIS-C and AVIRIS-NG are expected to be available in 2014 and beyond

- AVIRIS-NG paves the way for a HyspIRI-type VSWIR imaging spectrometer