Section 11

Comparison of ALI, Hyperion, and Landsat Data

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Hyperion Cross Comparison

**Goal:**
- Combine the Hyperion narrow hyperspectral bands to synthesis the ALI and Landsat broader multi-spectral bands

**General Process**
- Sum the percentage of selected applicable Hyperion bands
- Percentage is calculated by comparing the spectral response of the hyperspectral and multispectral

**Mathematically**
- Convolve the Hyperion gaussian spectral response with the broad band spectral response
- Normalize carefully to ensure proper units
- Details can be provided upon request
Example: Well sampled by Hyperion

ALI Band 5: Hyperion Weight per Spectral Channel

Response

Wavelength

- ALI Spectral Response
- Hyperion Weight
Example: Moderately Sampled by Hyperion

ALI Band 4: Hyperion Weight per Spectral Channel

- ALI Spectral Response
- Hyperion Weight

Wavelength

Response

650 700 750 800 850 900 950
Desert Sites Used For Cross Calibration

Lake Frome

Railroad Valley

Selected uniform regions spanning field-of-view and intensity level
# Hyperion – Landsat Comparison

<table>
<thead>
<tr>
<th>Landsat Order</th>
<th>Landsat Center Wavelength</th>
<th>Landsat Bandwidth</th>
<th>Multiply Hyperion Synthesized Band to Obtain Landsat Radiance</th>
<th>Repeatability of Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>483 nm</td>
<td>65 nm</td>
<td>1.109</td>
<td>0.19%</td>
</tr>
<tr>
<td>2</td>
<td>565 nm</td>
<td>180 nm</td>
<td>1.049</td>
<td>0.43%</td>
</tr>
<tr>
<td>3</td>
<td>660 nm</td>
<td>60 nm</td>
<td>1.051</td>
<td>0.18%</td>
</tr>
<tr>
<td>4</td>
<td>825 nm</td>
<td>125 nm</td>
<td>1.114</td>
<td>0.60%</td>
</tr>
<tr>
<td>5</td>
<td>1650 nm</td>
<td>200 nm</td>
<td>1.182</td>
<td>0.24%</td>
</tr>
<tr>
<td>7</td>
<td>2210 nm</td>
<td>260 nm</td>
<td>1.165</td>
<td>1.79%</td>
</tr>
</tbody>
</table>

Scenes: Railroad Valley day 133, Railroad Valley day 085 and Lake Frome day 21
## Hyperion – ALI Comparison

<table>
<thead>
<tr>
<th>ALI Order</th>
<th>ALI Center Wavelength</th>
<th>ALI Bandwidth</th>
<th>Multiply Hyperion Synthesized Band to Obtain ALI Radiance</th>
<th>Repeatability of Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>1p</td>
<td>442 nm</td>
<td>20</td>
<td>0.968</td>
<td>2.61%</td>
</tr>
<tr>
<td>1</td>
<td>485 nm</td>
<td>65</td>
<td>1.051</td>
<td>1.00%</td>
</tr>
<tr>
<td>2</td>
<td>568 nm</td>
<td>80</td>
<td>1.012</td>
<td>0.48%</td>
</tr>
<tr>
<td>3</td>
<td>661 nm</td>
<td>60</td>
<td>1.007</td>
<td>0.85%</td>
</tr>
<tr>
<td>4</td>
<td>791 nm</td>
<td>30</td>
<td>1.091</td>
<td>1.98%</td>
</tr>
<tr>
<td>4p</td>
<td>866 nm</td>
<td>45</td>
<td>1.122</td>
<td>2.46%</td>
</tr>
<tr>
<td>5p</td>
<td>1244 nm</td>
<td>100</td>
<td>1.270</td>
<td>1.14%</td>
</tr>
<tr>
<td>5</td>
<td>1640 nm</td>
<td>200</td>
<td>1.343</td>
<td>0.37%</td>
</tr>
<tr>
<td>7</td>
<td>2226 nm</td>
<td>270</td>
<td>1.230</td>
<td>1.00%</td>
</tr>
</tbody>
</table>

Note: 1p, 4, 4p, smallest bandwidth and largest repeatability error

Scenes: Railroad Valley day 133, Railroad Valley day 165 and Coleambally day 65.
Check Synthesis Process

- Convert ALI (or Landsat) to radiance
- Multiply Hyperion Aggregated data by previously measured Hyperion-ALI (or Landsat) comparison factors
- Calculate the band ratios for each data set
  - Red $\rightarrow$ ratio of bands 5/7, Green $\rightarrow$ ratio of bands 3/1 and Blue $\rightarrow$ ratio of bands 4/5
  - Then light blue $\rightarrow$ beach altered rocks, red $\rightarrow$ clay and alunite bearing rocks, green $\rightarrow$ iron bearing rocks
Check Synthesis Process

- Cuprite Comparison
  - Compare color ratio composites qualitatively
  - Compare color ratio line plots quantitatively
  - Compare close ups
Cuprite: Color Band Ratio Composite

Hyperion Aggregated to Synthesis Landsat-7

Landsat-7
Cuprite: Hyperion - Landsat Comparison

Band 5/7 Ratio, Red in the RGB

Note: Landsat is twisted relative to Hyperion
Cuprite: Hyperion - Landsat Comparison

Band 3/1 Ratio, Green in the RGB

Note: Landsat is twisted relative to Hyperion
Cuprite: Hyperion - Landsat Comparison

Band 4/5 Ratio, Blue in the RGB

Note: Landsat is twisted relative to Hyperion.
Cuprite: Color Band Ratio Composite

Hyperion Aggregated to Synthesis ALI

ALI

Known bad detectors in ALI
Cuprite: Hyperion – ALI Comparison

Band 5/7 Ratio, Red in the RGB

FOV (Hyperion)

Band 5/7 Comparison Ratio

- ALI
- Hyperion Synthesis of ALI
Cuprite: Hyperion – ALI Comparison

Band 3/1 Ratio, Green in the RGB

Band 3/1 Ratio Comparison

- ALI
- Hyperion Synthesis of ALI

FOV (Hyperion)
Cuprite: Hyperion – ALI Comparison

Band 4/5 Ratio, Blue in the RGB

- ALI
- Hyperion Synthesis of ALI
Cuprite: Comparison Close Up

Hyperion Aggregated to Synthesis Landsat 7

ALI

Landsat 7

Hyperion Aggregated to Synthesis ALI
Check Synthesis Process

- Coleambally Comparison
  - Convert ALI (or Landsat) to radiance
  - Multiply Hyperion Aggregated data by previously measured Hyperion-ALI (or Landsat) comparison factors
  - Georectify Hyperion and Landsat data to ground control points
    - Transformation courtesy of CSIRO, Australia
  - Compare vegetation RGB color composites qualitatively
  - Compare color ratio line plots quantitatively
Coleambally: Hyperion–Landsat 432 Comparison

Hyperion Aggregated to Synthesis Landsat 7

Landsat 7

Line 1

→

Line 2
Profile at Line 1: Band 4-3-2 as Red-Green-Blue

- Landsat Red
- Landsat Green
- Landsat Blue
- Hyperion Synthesis of Landsat Red
- Hyperion Synthesis of Landsat Green
- Hyperion Synthesis of Landsat Blue
Profile at Line 2: Band 4-3-2 as Red-Green-Blue

Coleambally: Hyperion–Landsat Comparison
Coleambally: Hyperion–Landsat 751 Comparison
Hyperion-Landsat ETM+ SNR Comparison

Hyperion and Landsat SNR Comparison

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Landsat 7 ETM+</th>
<th>Hyperion 10 nm resolution</th>
<th>Hyperion Grouped to L7</th>
</tr>
</thead>
<tbody>
<tr>
<td>483</td>
<td>Low Gain 80</td>
<td>High Gain 82</td>
<td>172</td>
</tr>
<tr>
<td>565</td>
<td>Low Gain 98</td>
<td>High Gain 103</td>
<td>221</td>
</tr>
<tr>
<td>660</td>
<td>Low Gain 81</td>
<td>High Gain 83</td>
<td>199</td>
</tr>
<tr>
<td>825</td>
<td>Low Gain 99</td>
<td>High Gain 109</td>
<td>119</td>
</tr>
<tr>
<td>1650</td>
<td>Low Gain 80</td>
<td>High Gain 85</td>
<td>77</td>
</tr>
<tr>
<td>2210</td>
<td>Low Gain 59</td>
<td>High Gain 61</td>
<td>38</td>
</tr>
</tbody>
</table>

L7 Low Gain
L7 High Gain
Hyperion
Hyperion Grouped to L7
Hyperion – Landsat – ALI
Summary

- **Hyperion hyperspectral aggregated to Landsat and ALI bands**
  - Measured absolute ratio for Landsat/Hyperion and ALI/Hyperion

- **Ratio used to created Hyperion synthesis of Landsat and synthesis of ALI**

- **Results indicate comparison independent of scene, field-of-view, intensity**
Synthesis capability allows multiple intercomparison of different instruments in a common base

Many multispectral do not have many options of bands. By binning Hyperion can determine which bands are optimum for specific applications.

Determine different information from Hyperspectral over multispectral