EO-1 and its potential coastal applications

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Outline:

• **Project description**
  sensors
  objectives
  participants

• **Project status**
  examples of Hyperion collections
  example of processed Hyperion data

3. **Preliminary findings**

4. **Next**
Project description: a. sensors on EO-1

Launched on November 21, 2000, for land applications.

EO-1

i. Atmosphere Corrector (AC)
ii. Advanced Land Imager (ALI)
iii. Hyperion
• **Sensor continued:**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>AC</th>
<th>ALI</th>
<th>Hyperion</th>
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</thead>
<tbody>
<tr>
<td>Spectral Range</td>
<td>0.9 – 1.6 um</td>
<td>0.44-2.4 μm</td>
<td>0.43-2.4 μm</td>
</tr>
<tr>
<td>Spectral Resolution</td>
<td>2.8 – 9 nm</td>
<td>Variable</td>
<td>~10 nm</td>
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<tr>
<td>Spectral Coverage</td>
<td>Continuous</td>
<td>Discrete</td>
<td>Continuous</td>
</tr>
<tr>
<td>Total # of Bands</td>
<td>256</td>
<td>10</td>
<td>220</td>
</tr>
<tr>
<td>Spatial Resolution</td>
<td>250m</td>
<td>30m</td>
<td>30m</td>
</tr>
<tr>
<td>Swath Width</td>
<td>185 km</td>
<td>37Km</td>
<td>7.7Km</td>
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EO-1 and Landsat 7 Descending Orbit Ground Tracks

spatial coverage

Landsat 7 ETM+

EO-1 AC

EO-1 ALI

EO-1 Hyperion
Orbit of EO-1 and Landsat

- Landsat ETM+ Multispectral Swath Coverage (185 km @ 30 m)
- ALI Multispectral Swath Coverage (37 km @ 30 m)
- Atmospheric Corrector Hyperspectral Coverage (185 km @ 125 / 250 m)
- TRWIS Underflight (FOV varies with altitude)
- AVIRIS Underflight (10 km @ 20 m)
- Hyperion Hyperspectral Swath Coverage (7.5 km @ 30 m)
Characters of Hyperion:

NASA’s only hyperspectral sensor in orbit!!!

- **High spectral capability** (430 – 2400 nm, ~every 10 nm)
- **High spatial resolution** - 30m GSD
- **Low Signal-to-Noise Ratio** (SNR ~50 - 160)
- **Narrow swath coverage** (7 km)
- **Repeat time** (16 days for same coverage area)
- **Not real time capability** – (~20-day delay)
Question:
Are there any potentials for ocean/coastal applications?
What does the color difference mean?

Different water?
Different bottom?
Or different depth?

Can they be separated??
and get meaningful quantities.
• **Project description: b. objectives**

  i. Evaluate EO-1 potentials for coastal waters

  ii. Develop/compare atmosphere correction

  iii. Compare retrieved environmental properties
- **Project description:** c. participants

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
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<tr>
<td>Robert Arnone</td>
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2. Project status:

Over 30 Scenes Ordered and Collected for Coastal areas

- 7 co-incident field cruises
  - Looe Key (FL Keys) - Clear Waters
  - Horn Island (MS) - Turbid waters
  - Apalachicola Bay - Clear/turbid waters
  - Fort Lauderdale – Clear/turbid waters
  - Chesapeake Bay – turbid waters
  - MOBY – clear waters
  - Oahu bay -

- Measurements include (not necessary ALL):
  - water IOP/AOP
  - Laser bathymetry
  - Atmosphere properties

In the earlier stage of data processing

- atmosphere correction
- Water/bottom property retrieval
- Comparison/validation
2.1 Example of Hyperion collections:

- Chesapeake Bay, 6 Sep ‘02
- Looe Key, FL, 26 Oct ‘02
- Florida Bay, 3/19/04
- Smith Island, 3/12/04
2.2 Example of processed Hyperion data

1. Calibrated Level-1 absolute radiance data are provided through USGS.
   TOA radiance accuracy is within 5% (Barry et al. 2001)

2. Atmosphere correction → Rrs
testing different algorithms

3. Rrs → water/bottom properties
One example …

**Rrs comparison**

Red: *insitu* Rrs
Green: Hyperion Rrs

("MOBY")
Retrieve shallow-water Properties

(Hyperspectral Optimization Process codE) 
(Lee et al. 1999, 2001)

HOPE

(H, IOP, ...)

(bathymetry)

Optical properties

(meas. vs mod. Rrs)
Results from Hyperion

Different patterns!

Bottom depth (m)  Water absorption at 440 nm (m$^{-1}$)  Bottom reflectance
Results using Hyperion Rrs

Hyperion Depth versus CHARTS Soundings

Depth from laser sounding (m)

Depth from Hyperion (m)
3. Preliminary findings:

a. Hyperion DOES have the sensitivity for many coastal applications.

b. Water and/or bottom properties could be well retrieved when high-quality Rrs are derived.

Issues:

a. No effective bands below 430 nm
b. TOA radiance error is ~5%
 c. Lacking information for accurate georeference
d. No automatic system for atmosphere correction … yet
4. Next:

- Validate Hyperion results
- Apply the above process methods to other Hyperion data
- Try/Test with ALI data
- Analyze the limits of Hyperion/ALI data and the process methods
- **Make recommendations regarding future space-borne hyperspectral sensors**

*To be continued ...*