Comparing the performance of airborne and spaceborne imaging spectrometers (AVIRIS, Hymap, Hyperion/EO-1, WF-1/Orbview-4, COIS/NEMO, and HYDICE)

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NEMO/COIS

Naval EarthMap Observer (NEMO) satellite
- Demonstrate the use of hyperspectral imaging
  - Characterization of the littoral environment
  - On-board processing using ORASIS algorithm
  - Dual-use (DOD and commercial) applications
  - Real-time downlink of data and end-products
- Sun-synchronous, 605 km altitude, 10:30 am equator crossing
- Seven day repeat coverage
- Coastal Ocean Imaging Spectrometer (COIS) under development at SAIC/San Diego
NEMO Mission Drivers

- Ocean and shoreline character
  - 5% ocean reflectivity (fairly dark)
  - Straylight, polarization, and calibration impacts
- Trade spatial resolution
  - Wider swaths
  - Higher SNR
- 3 collection modes (60 m, 30m, 30m full)
  - To fulfill mission objectives
COIS Details

- Pushbroom imaging spectrometer
- 0.4 to 2.5 μm range, 10 ± 2 nm resolution
- All-reflective optics
- Two spectrometers, dichroic after beam splitter
- Offner spectrometer form, holographic grating
- Silicon and MCT area arrays 1000 samples wide
- Boresighted to 5 m spatial resolution pan imager (PIC)
COIS and PIC Sensors On NEMO

COIS AND PIC ENCLOSURE REMOVED FOR CLARITY

Drawing: September 19, 1988 at 14:00 ZED 023 PM
NEMO References

Website:  http://nemo.nrl.navy.mil

Hyperspectral remote sensing technology (HRST) program and the Naval EarthMap
Observer (NEMO) satellite (Paper #: 3437-44)
Naval EarthMap Observer (NEMO) science and naval products (Paper#: 3437-45)
On-board hyperspectral compression and analysis system for the NEMO satellite (Paper #: 3437-46)
NEMO satellite sensor imaging payload (Paper #: 3437-47)

Contact: Tom Wilson, wilson@ncst.nrl.navy.mil
Orbview-4/Warfighter-1

- Airforce Research Lab Sponsor
- Demonstration of hyperspectral technology for target detection and terrain categorization for the military
- WF-1 is a tag-along to Orbview-4 Satellite
  - 1 meter panchromatic
  - 4 meter multispectral
- Orbital Sciences is Prime Contractor
- WF-1 currently under construction at Northrop-Grumman
WF-1 Details

- Pushbroom imaging spectrometer
- 8 meter spatial resolution
- 0.45 to 2.5 μm range, 11 nm resolution
- All-reflective optics
- One spectrometer, 2 dichroics after grating
- Offner spectrometer form, e-beam grating
- Si, InGaAs, and MCT area arrays
- 640 samples wide
- Currently under construction
OV-4/WF-1 References

• Very little published material exists for the Warfighter Sensor due to classification and commercial proprietary concerns

• Websites
  – http://www.vs.afrl.af.mil/vsd/
  – http://www.fas.org/spp/military/program/imint/warfighter.htm
EO-1/Hyperion

- NASA Code Y Sponsor
- Demonstration of:
  - Advanced Landsat imager technologies
  - Formation flying (Terra, Landsat 7, and EO-1)
- Hyperion a separate hyperspectral imaging sensor
- Other sensors on EO-1
  - Advanced Land Imager (ALI)
  - LEISA atmospheric corrector (LAC)
- TRW built and delivered Hyperion
- Launch is scheduled for April 2000
Hyperion Details

- Pushbroom imaging spectrometer
- 30 meter spatial resolution
- 0.45 to 2.5 µm range, 11 nm resolution
- All-reflective optics
- Two spectrometers, dichroics after entrance slit
- Offner spectrometer form, e-beam grating
- Si, MCT area arrays
- 256 samples wide
Hyperion References

- Website: eo1.gsfc.nasa.gov
HYDICE

- Naval Research Lab/CMO sponsor
- Hyperspectral Digital Image Collection Experiment
  - Hyperspectral MASINT Support to Military Operations
    - Measures and Signatures Intelligence (MASINT)
- Flies on ERIM International CV-580
- Sensor built by Hughes Danbury Optical Systems (HDOS)
  - Now Raytheon Danbury Optical Systems
HYDICE Details

- Pushbroom imaging spectrometer
- 0.5 mrad IFOV (1 to 5 meter spatial resolution)
- 0.40 to 2.5 μm range, 5 to 20 nm resolution
- Prism spectrometer
- Single InSb Area array 320 x 210 Format
  - Special passivation layer for visible response down to blue
- Selectable frame rate and integration time
- Sensor is cooled to 7°C to reduce thermal background
- Integrating sphere onboard calibrator
- Zeiss stabilization mount and DGPS
Hymap sensor
Hymap Details

Manufactured by Integrated Spectronics (Australia)
Whiskbroom scanner, 62 ° FOV
line array detectors
100 - 200 wavelength channels
bandwidths generally in 10 - 20 nm range
high signal to noise ratio, >500:1
2 - 10 metre spatial resolution
Operates in light aircraft with standard camera port
3 axis gyro-stabilised platform
<table>
<thead>
<tr>
<th>Sensor(s)</th>
<th>Platform</th>
<th>Hyperion</th>
<th>AVIRIS</th>
<th>Hymap, Probe</th>
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<td>NEMO Satellite</td>
<td>EO-1</td>
<td>ER-2 Twin Otter</td>
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<td>20 m, 4 m</td>
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<td>3 - 10 m</td>
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