Overview of EO-1

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LCLUC Science Team Meeting

November 2001

EO-1 Mission Facts

ORBIT

- 705 Km altitude Sun-synchronous, circular orbit inclined at 98.2°
- Descending node with an equatorial crossing about one minute behind Landsat 7

LAUNCH

- Launch Date: Nov. 21, 2000
- Launch Vehicle: Delta 7320

ADVANCED LAND IMAGER (ALI)
Multispectral Pushbroom Imager

HYPERION
Hyperspectral Imaging Spectrometer

ATMOSPHERIC CORRECTOR (AC)
Wedge Imaging Spectrometer

Wide-band
Advanced
Recorder /
Processor

X-Band Phased Array Antenna

C&DH
S-Band Antenna

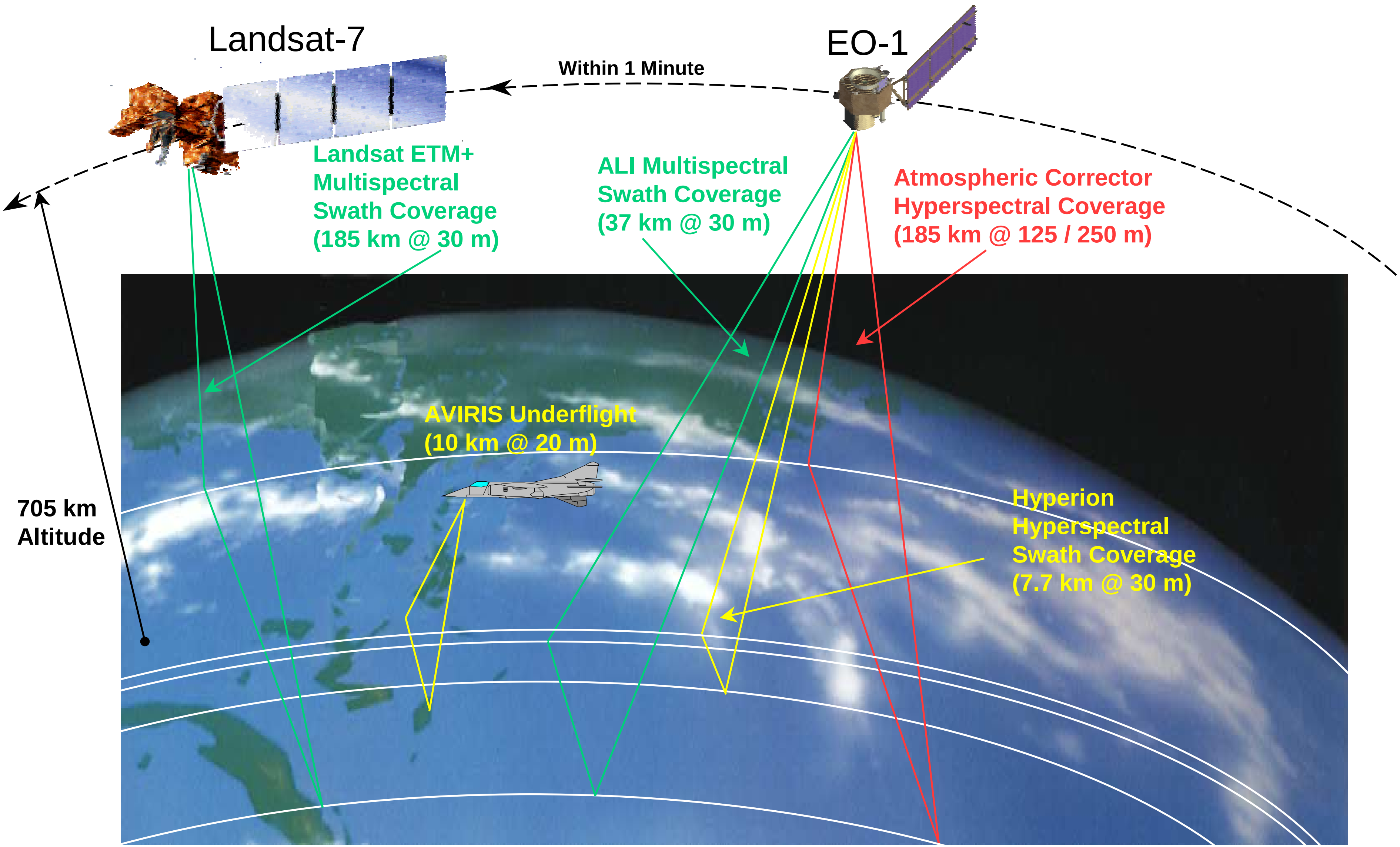
EO-1 Instrument Overviews

	Landsat 7	EO-1	EO-1	
Parameters	ETM+	ALI Multispectral	HYPERION	AC
Spectral Range	0.4 - 2.4 µm *	0.4 - 2.4 µm	0.4 - 2.5 µm	0.9 - 1.6 µm
Spatial Resolution	30 m	30 m	30 m	250 m
Swath Width	185 Km	37 Km	7.5 Km	185 Km
Spectral Resolution	Variable	Variable	10 nm	3 - 9 nm **
Spectral Coverage	Discrete	Discrete	Continuous	Continuous
Pan Band Resolution	15 m	10 m	N/A	N/A
Total Number of Bands	7	10	220	256

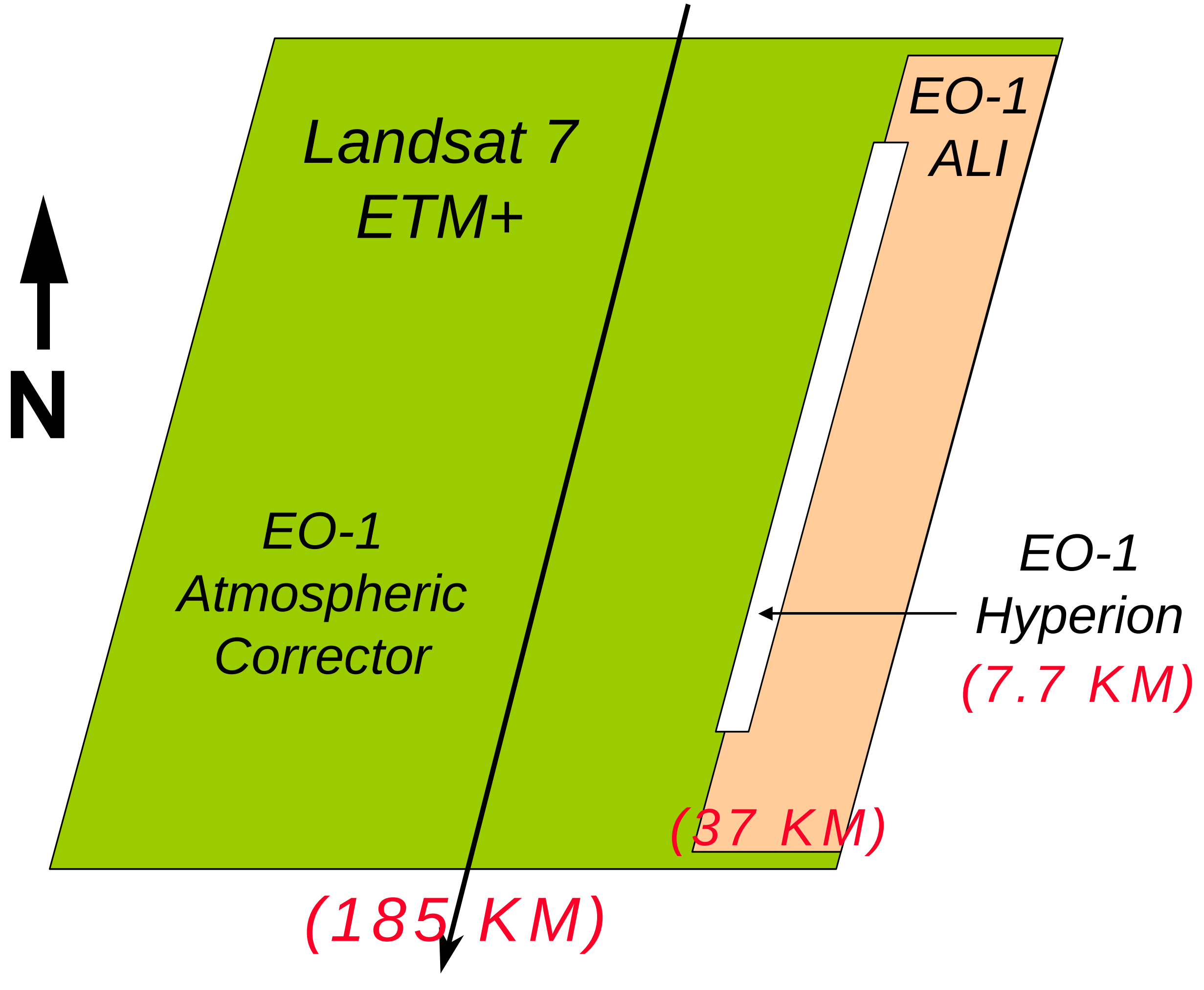
** Excludes thermal channel*

*** 35/55 cm^{-1} constant resolution*

EO-1 and Landsat



EO-1 and Landsat 7 Descending Orbit Ground Tracks



EO-1 Scene Tracking Statistics

Total Scheduled Scenes	2047
Level-0 Data Processed	1881
Total Scenes Shipped to PIs	1571

As of 10/24/01

Science Validation Team

- **Instrument Team** — **Day 1 to 90**
  - **Validate/re-establish and refine pre-launch characterizations**
  - **Provide technology validation**
- **NASA Selected Investigators** — **Day 61 to Present**
  - **Conduct scene based instrument performance characterizations**
  - **Assess capability for addressing earth remote sensing applications**
  - **Assist in technology validation**
  - **Facilitate commercial applications (CRSP/SSC)**
- **International Collaborators**
  - **Argentina, Australia, Brazil, Canada, Italy, Japan, Singapore**

Advanced Land Imager (ALI)

“First Light” image of Alaska

Why is the ALI pan band better than the ETM+ pan band?

Improved Radiometric resolution

- Superior signal-to-noise
- 12-bit versus 8-bit representation of dynamic range

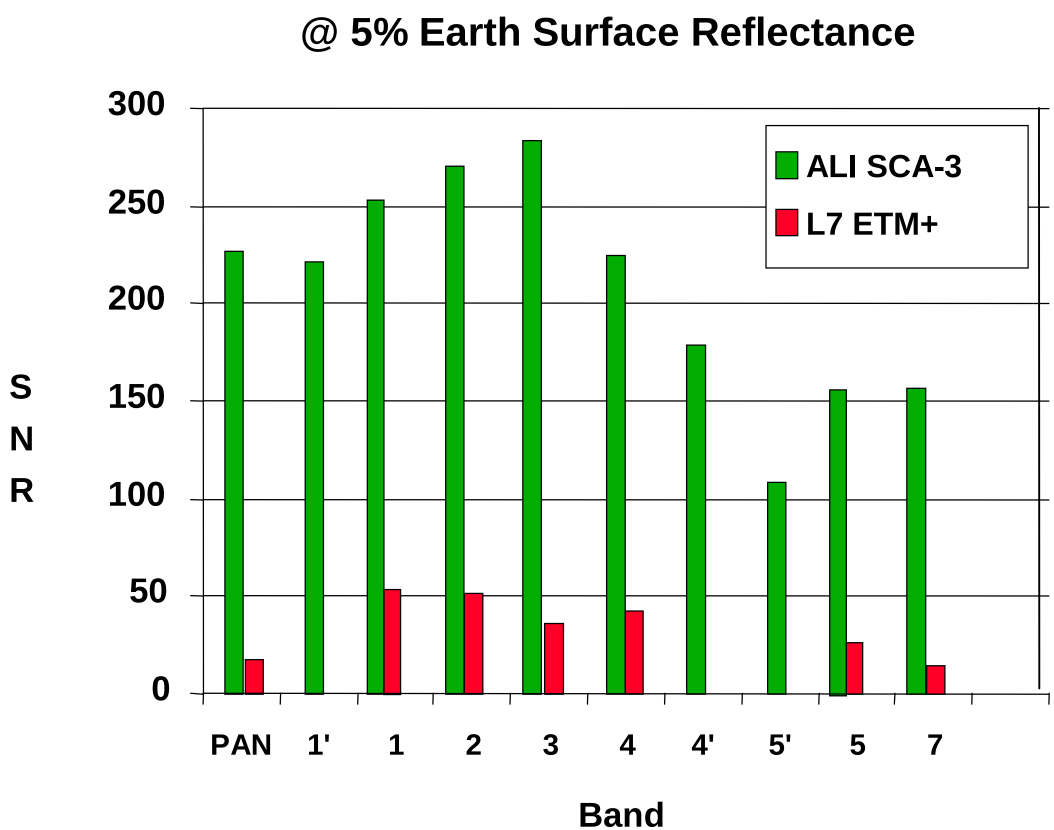
Inherently higher contrast measurement

- ALI pan restricted to 480 – 690nm VIS spectral interval
- ETM+ spans vegetation transition rise (520 – 900nm)

Smaller pixel size (IFOV)

- ALI pan IFOV is 10 meters
- ETM+ is nominally 15 meters (effectively 18 meters)

Advanced Land Imager Description



Band	Wavelength (nm)	Band	Wavelength (nm)
Pan	480-690	MS-4	775-805
MS-1’	433-453	MS-4’	845-890
MS-1	450-515	MS-5’	1200-1300
MS-2	525-605	MS-5	1550-1750
MS-3	630-690	MS-7	2080-2350

EO-1/ALI and IKONOS Comparison

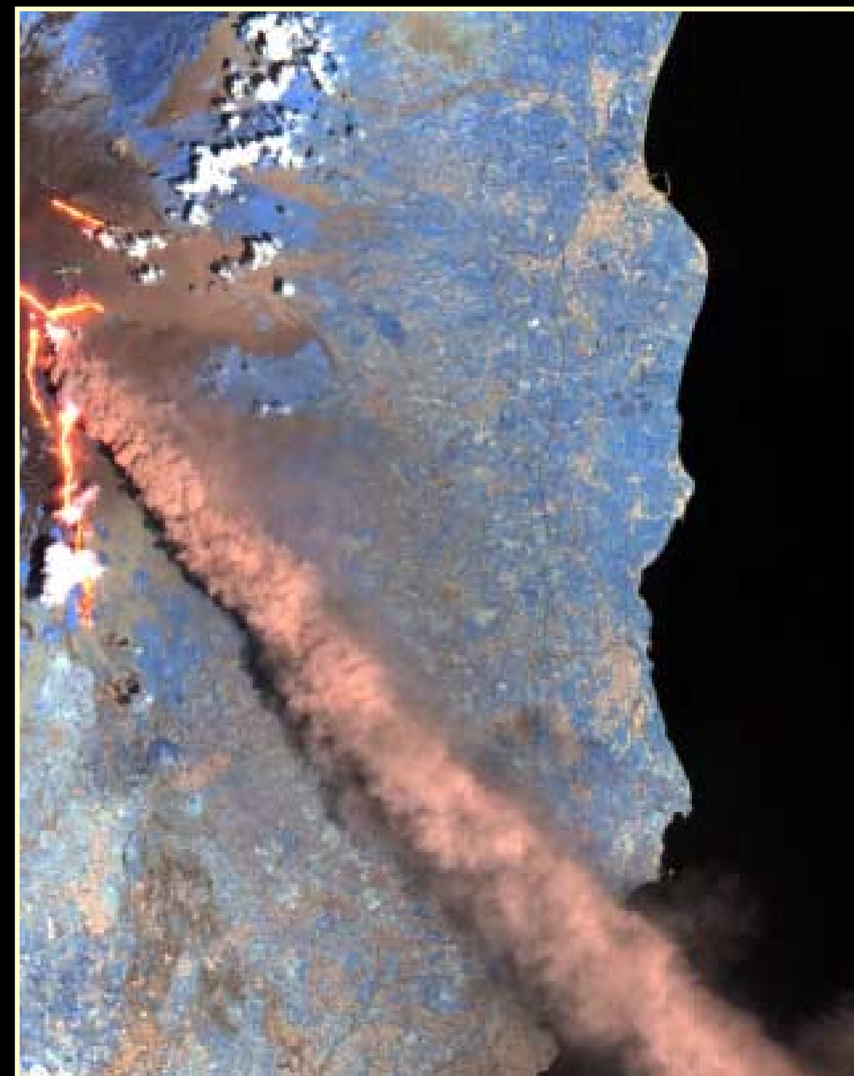
ALI Pan Enhanced 4-3-2 Composite
Washington DC, December 1 ,2000

IKONOS MS 4-3-2 Composite
Washington DC, April 1, 2000

Mount Etna - July 22, 2001

ALI Pan Enhanced 3-2-1

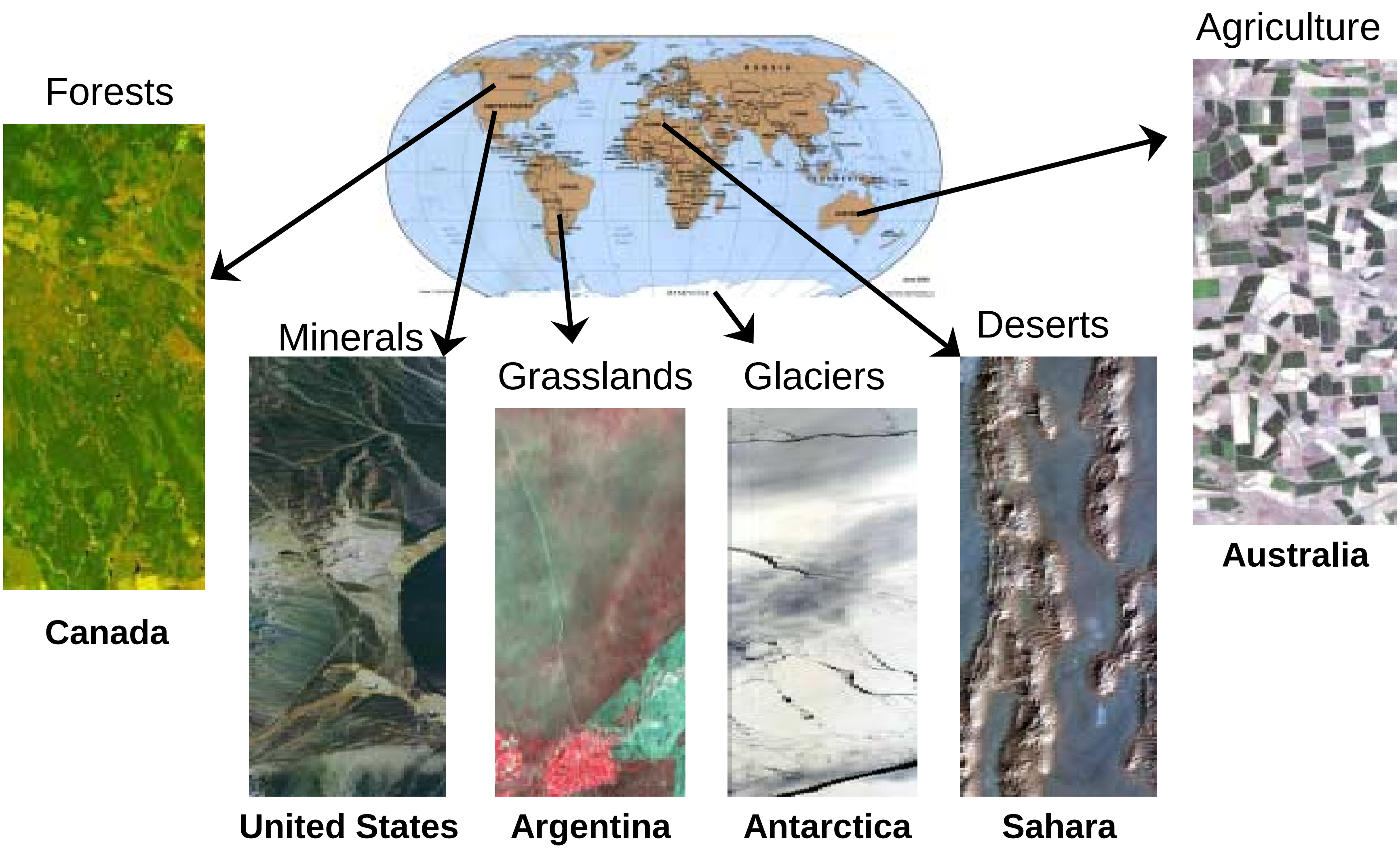
EO-1 ALI Bands 7-5-5’



Hyperion Imaging Spectrometer

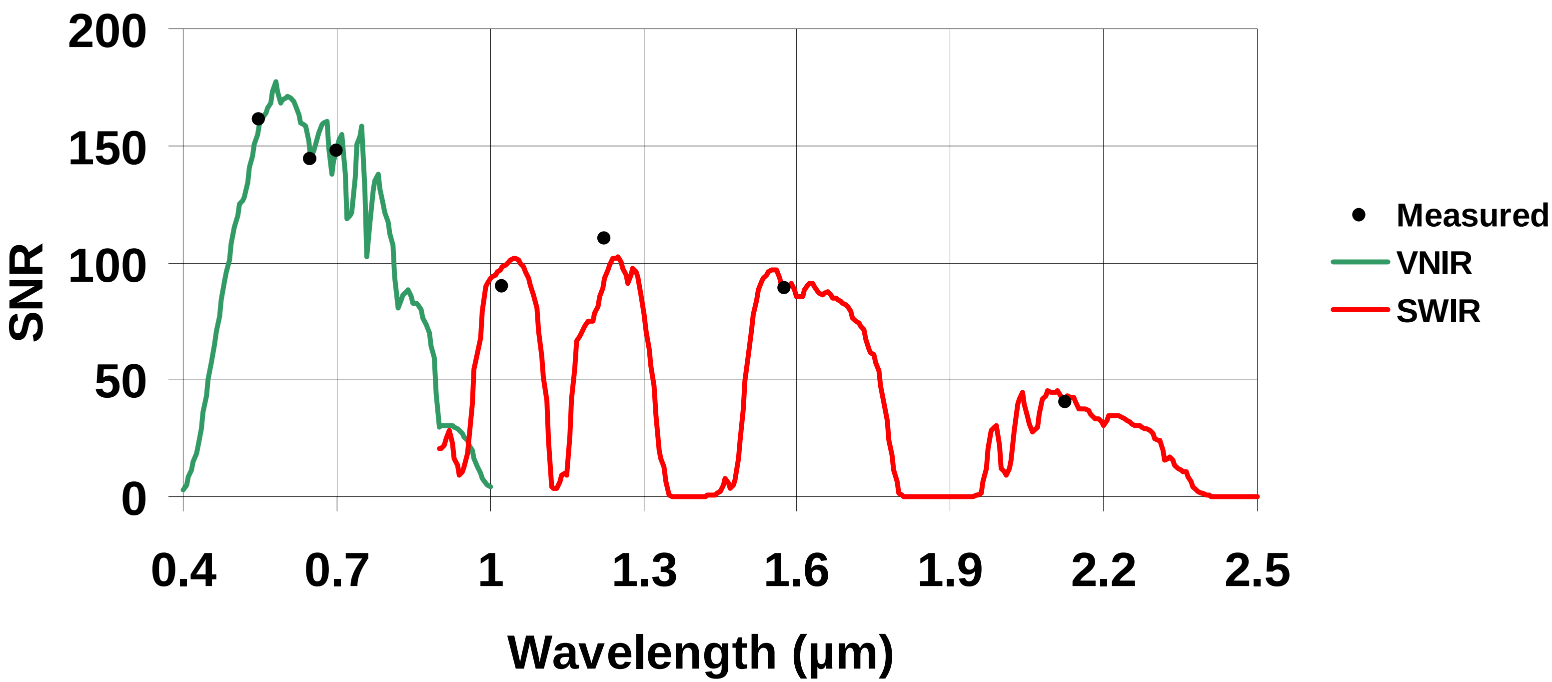
Hyperion Imaging

Hyperion addresses a broad range
of issues and world-wide sites



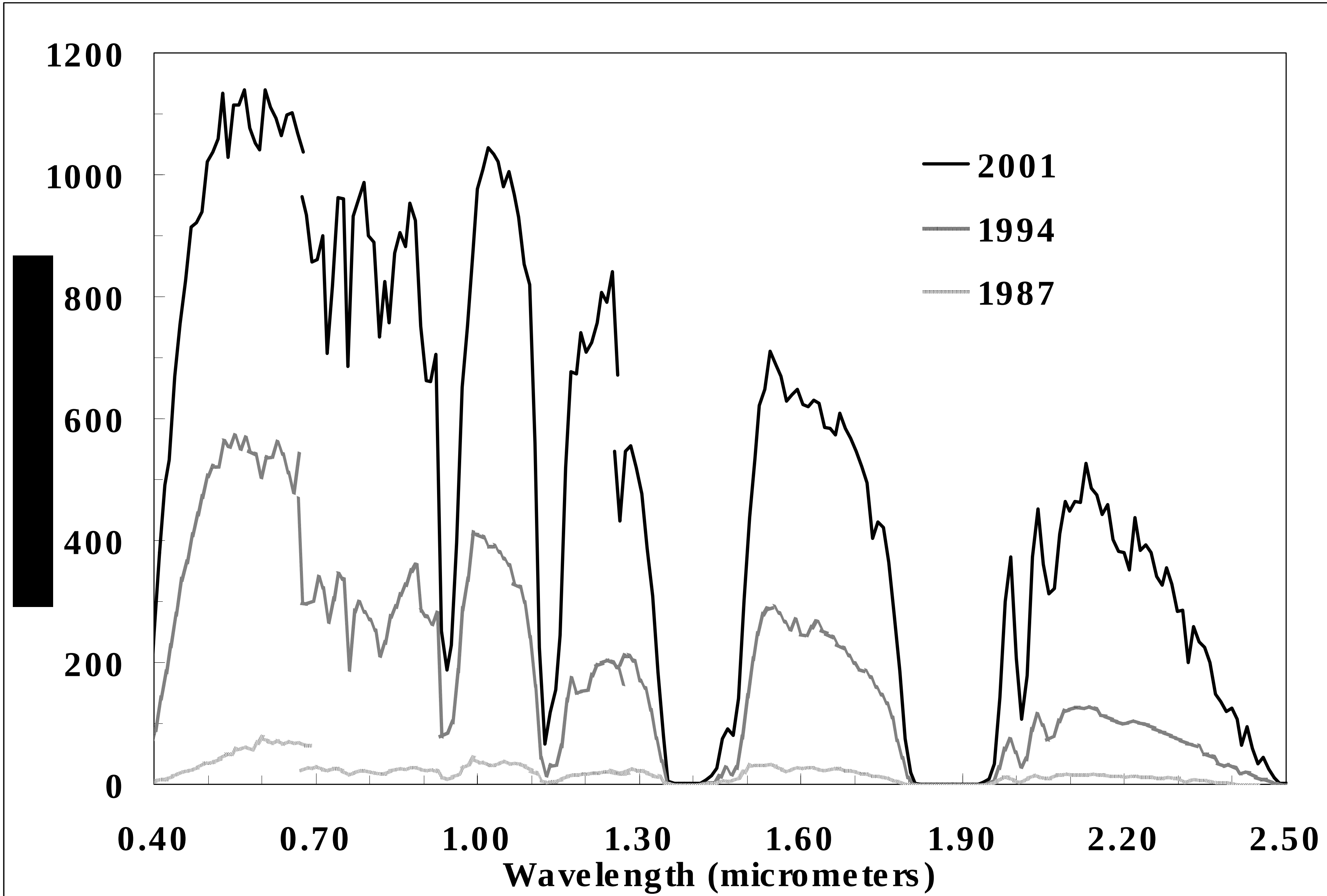
Hyperion S:N Performance

Radiometric performance model base on 60º Solar zenith angle and 30% surface reflectance standard mid-latitude summer scene.



Hyperion Measured SNR						
550 nm	650 nm	700 nm	1025 nm	1225 nm	1575 nm	2125 nm
161	144	147	90	110	89	40

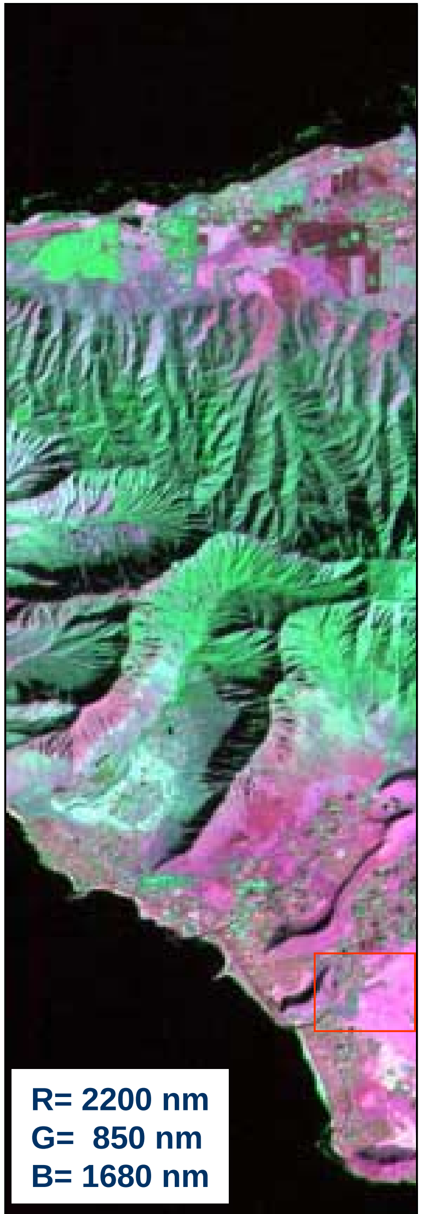
AVIRIS S:N Performance



Oahu

December 19, 2000

Image of Hyperion VNIR and SWIR bands



Spectrally aggregated Hyperion bands

Investigator Research Topics

Research Topic	Principal Investigator
Forest Logging in Amazonia	Asner, G. P., **University of Colorado**
Desertification	Asner, G. P., **University of Colorado**
Forest Composition & Function	Martin, M., **University of New Hampshire**
Inter-Sensor Calibration	Huete, A. R., **University of Arizona, Tucson**
Arid Vegetation Abundance	Mustard, J. F., **Brown University**
Tropical Forest Burn Scars	Liew, S. C., **National University of Singapore**
Forest Composition/Structure	Townsend, P. A., **University of Maryland**
Land Cover/Land Use	White, W. A., Crawford, M., **University of Texas at Austin**
Sustainable Forest Development	Goodenough, D. G., **Natural Resources Canada**
Monitoring Forest & Rangeland	Gong, P., **University of California, Berkeley**
Non-Native Plant Species	McGwire, K. **Desert Research Institute**

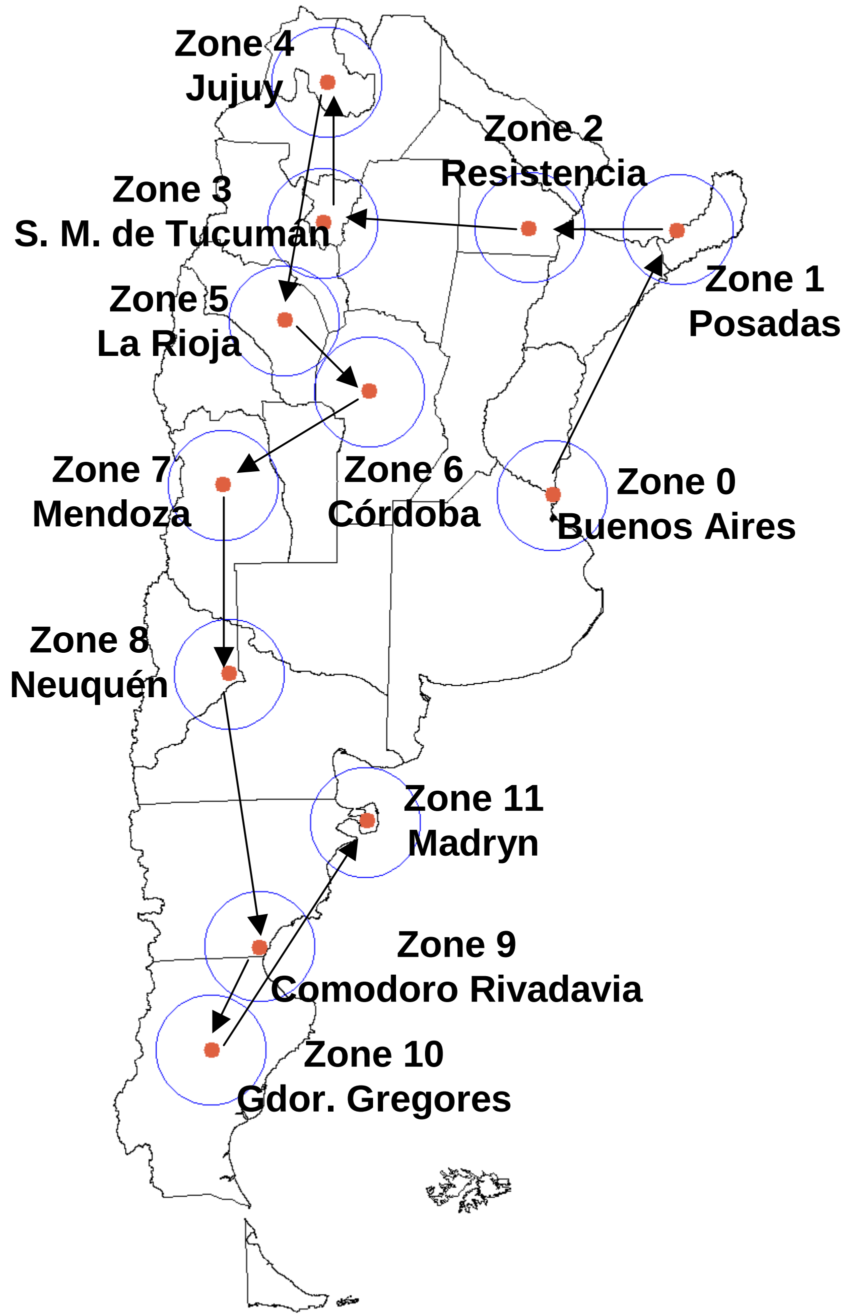
Investigator Research Topics (continued)

Research Topic	Principal Investigator
Invasive Plants: Chinese Tallow	Ramsey III, E. W., **USGS, Denver**
Invasive Leafy Spurge	Root, R., **USGS**
Agricultural Monitoring	Liang, S**.**, **USDA, Maryland**
Inter-Satellite Comparison	Moran, M. S. **USDA, Tucson, Arizona**
Fire Hazard Assessment	Roberts, D. A., **University of California, Santa Barbara**
Geologic Validation of Hyperion	Kruse, F. A., **AIG, Boulder, Colorado**
Volcanic Debris flow Hazards	Crowley, J. K**.**, **USGS, Reno, Nevada**
Analysis of Hot Spots	Flynn, L., **University of Hawaii**
Environmental Monitoring of Coastal/Inland Water in Japan	Matsunaga, T., **Tokyo Institute of Technology**
Oceanography, Pollution and Urban Mapping	Abrams, M. J., **JPL, California**; R. Bianchi and L. Alberotanza, **NRC, Italy**
Glaciological Applications	Bindschadler, R., **NASA/GSFC, Maryland**

Investigator Research Topics (continued)

Research Topic	Principal Investigator
Ecological Applications in Yellowstone National Park	Boardman, J. W., AIG, **Colorado**
Commercial Applications	Cassady, P. E., **Boeing, Washington**
Radiometric and Spatial Evaluation of ALI and Hyperion	Biggar, S. F., **University of Arizona**
Atmospheric Correction	Carlson, B. E., **NASA /GISS, New York**
Atmospheric Correction and Sparse Vegetation Mapping	Goetz, A. F. H., **University of Colorado**
Australian Hyperspectral Calibration and Validation Sites	Jupp, D. L. B., **CSRIO, Australia**
Integrated Assessment of EO-1 and Landsat Instrument Suites	Meyer, D. J., **EDC, South Dakota**
Canopy Temperature Estimation	Smith, J. A., **NASA GSFC, Maryland**
Lunar Calibration	Kieffer, H., **USGS, Flagstaff, AZ**

EO-1 Science Team Validation Campaigns

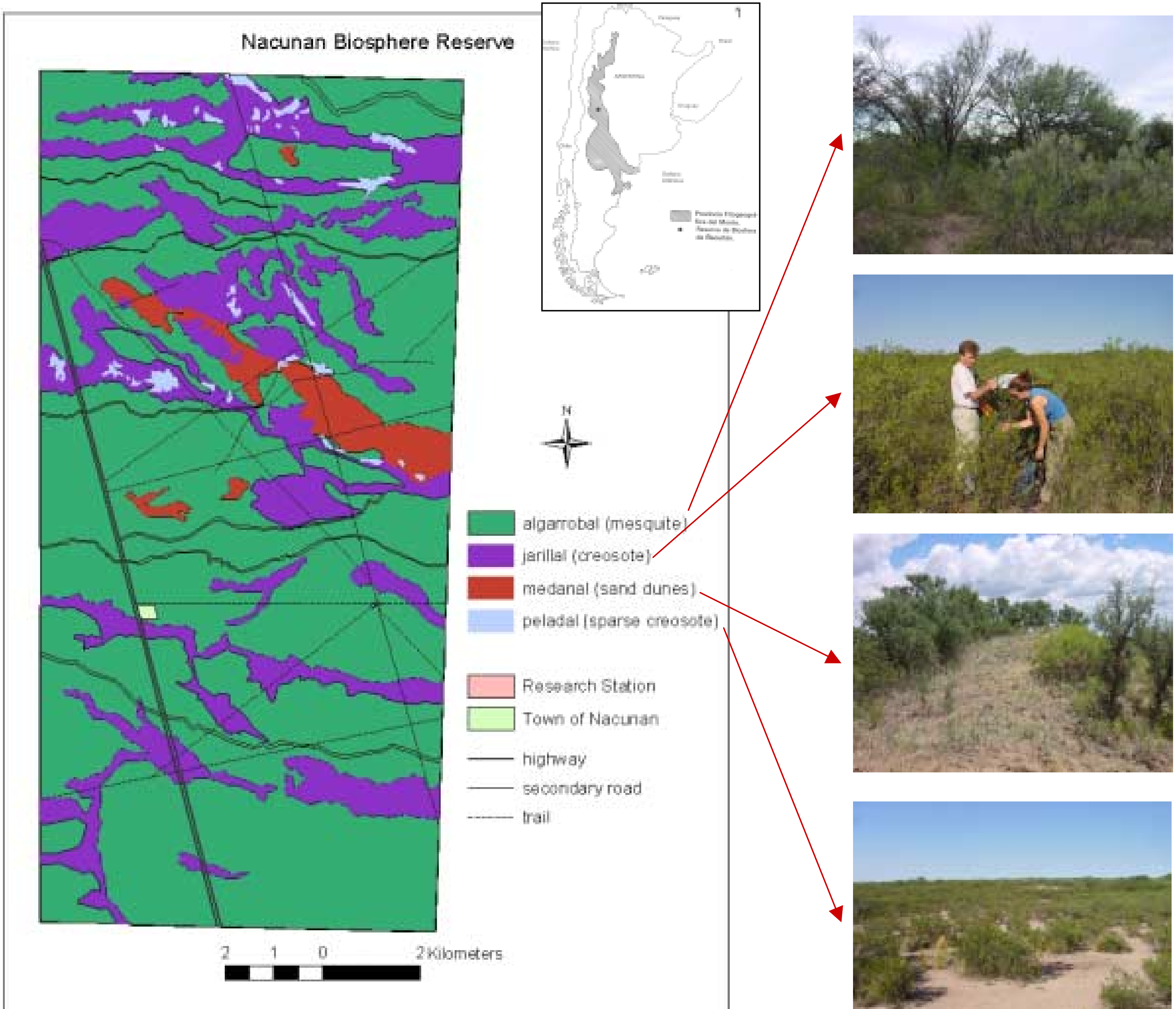


Argentina Validation Site Zone Map

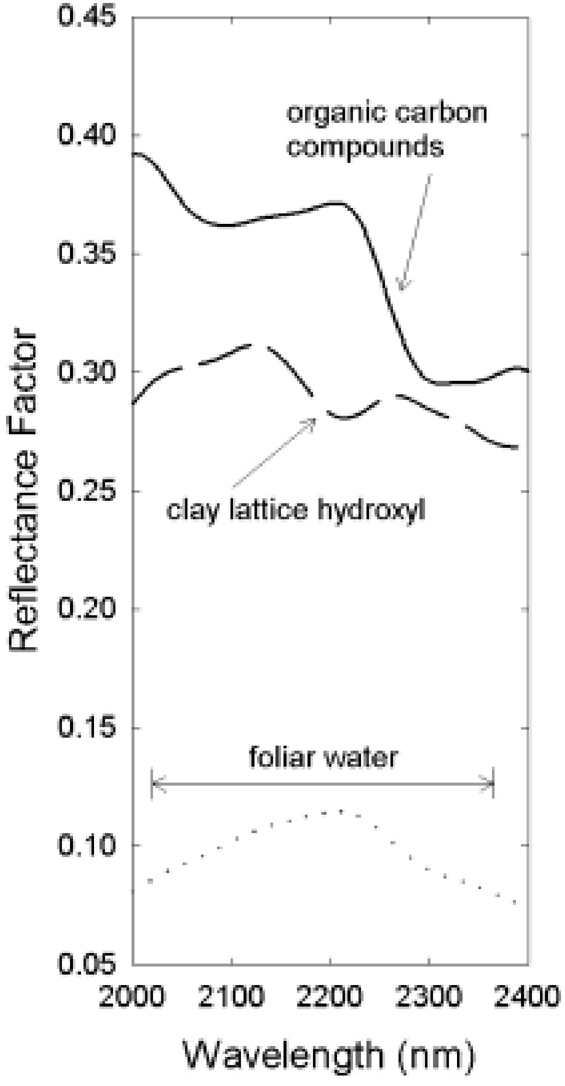
for AVIRIS and EO-1 overflights

AVIRIS Argentina 2001

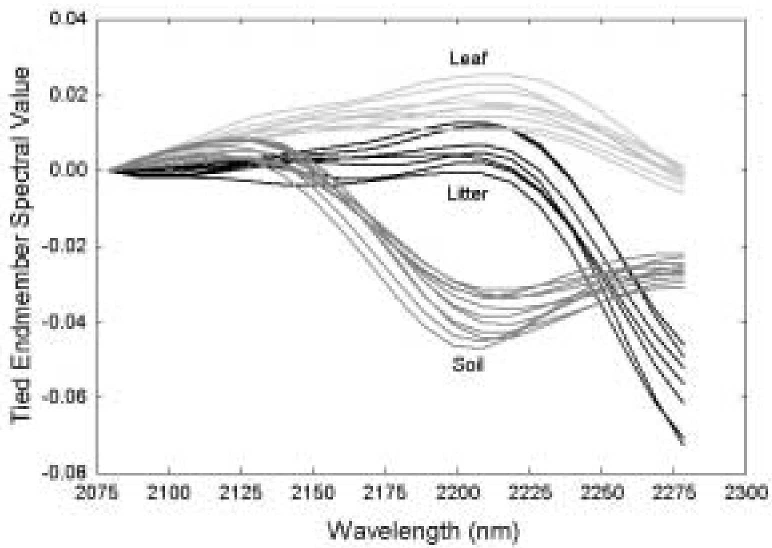
- Deployment: January 13 – February 20, 2001
- AVIRIS flew 25 days and collected more than 125 flight lines (Twin Otter)
- More than 216 gigabytes of data
- Two simultaneous under flights of EO-1
- Dozens of near-time image acquisitions between AVIRIS and EO-1
- About 70 calibrated/georectified data sets delivered to investigators to date


Nacunan Biosphere Reserve
algarrobal (mesquite)
jarillal (creosote)
medanal (sand dunes)
peladal (sparse creosote)
Research Station
Town of Nacunan
highway
secondary road
trail
N
2 1 0 2 Kilometers

High-Precision Surface Cover Analysis Using SWIR (2000-2400 nm) Spectra

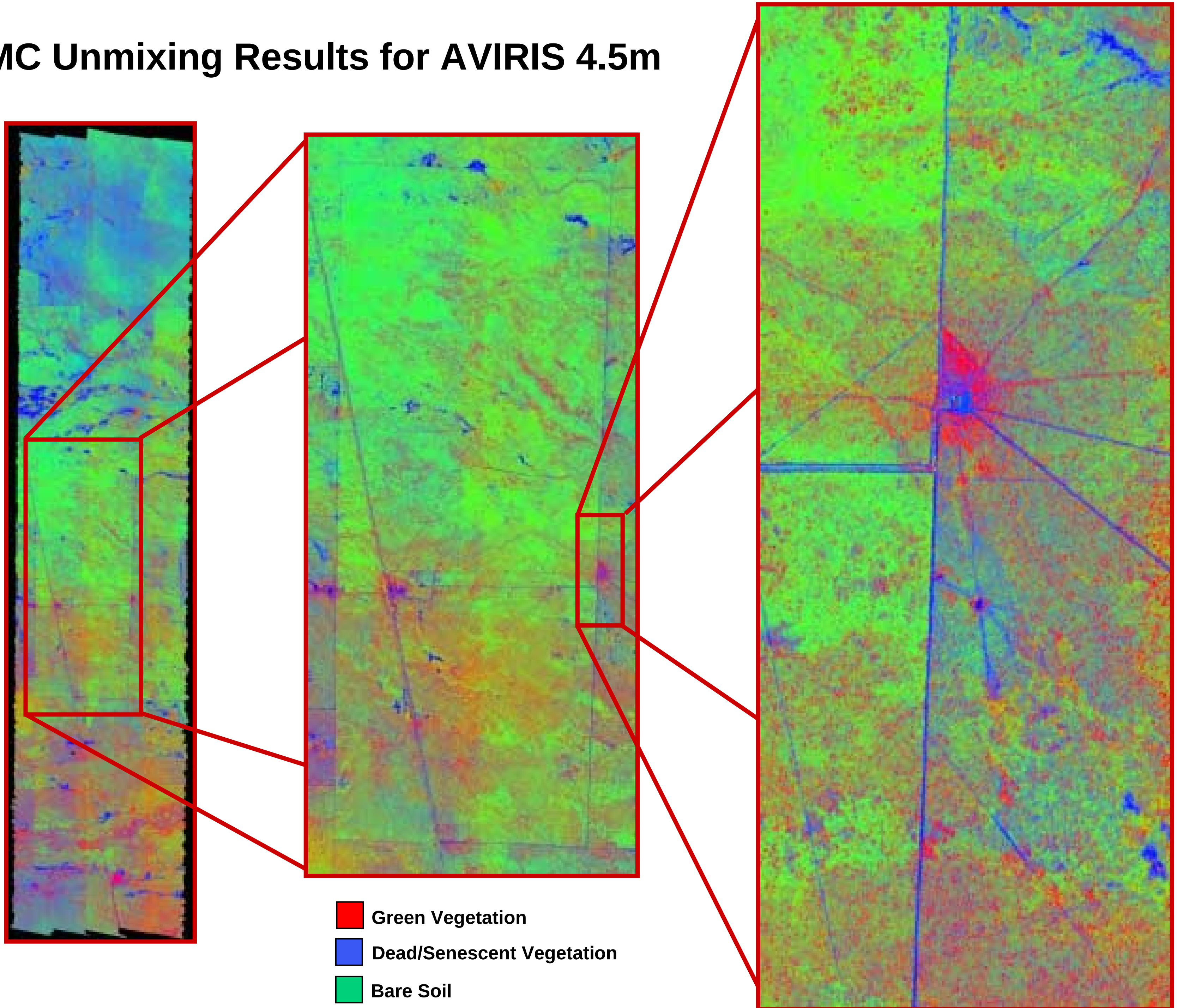


Tied Field Spectra Showing Full Arid/Semi-arid Site Variability

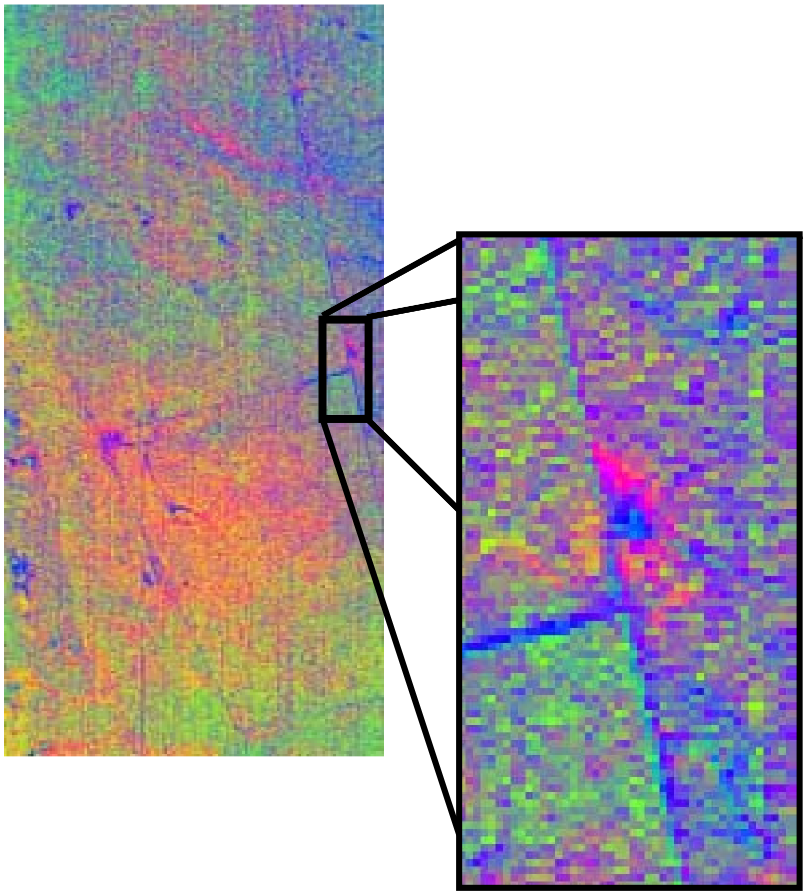


Tied at 2080nm

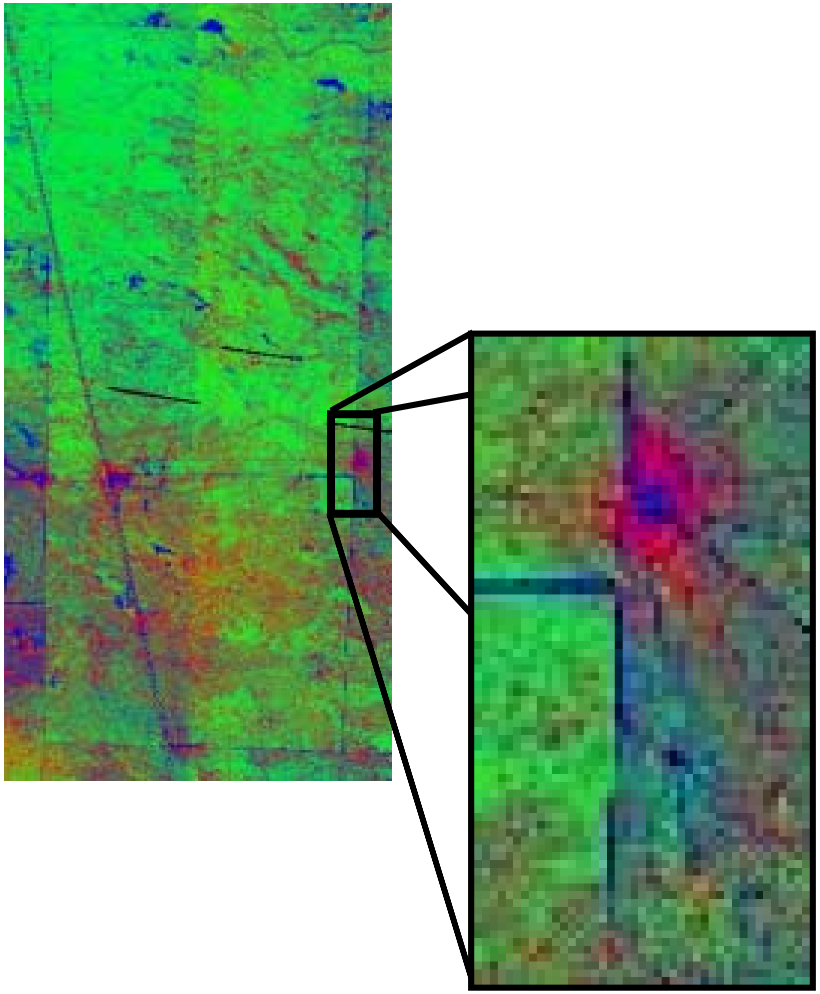
MC Unmixing Results for AVIRIS 4.5m



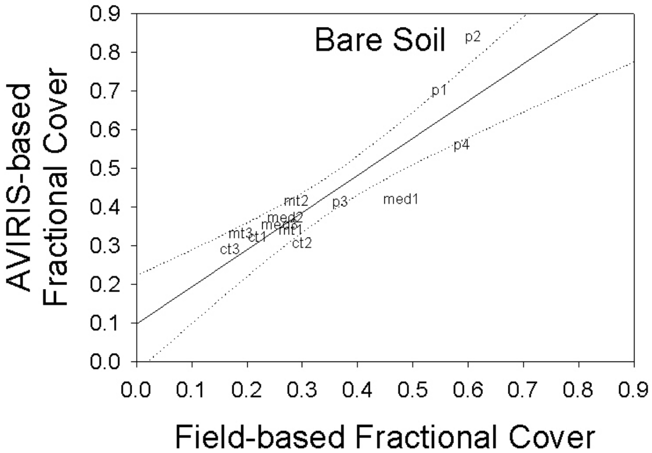
Hyperion-30m MC Unmixing



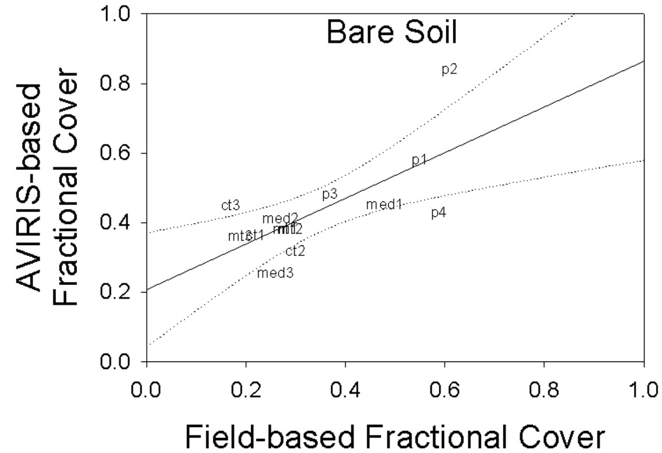
AVIRIS-30m MC Unmixing



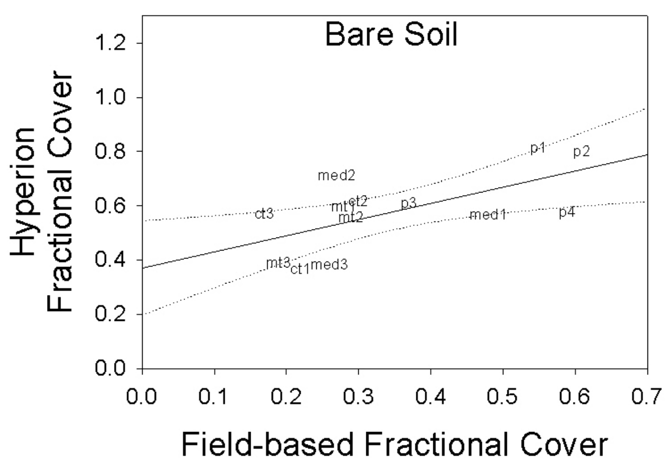
AVIRIS-4m



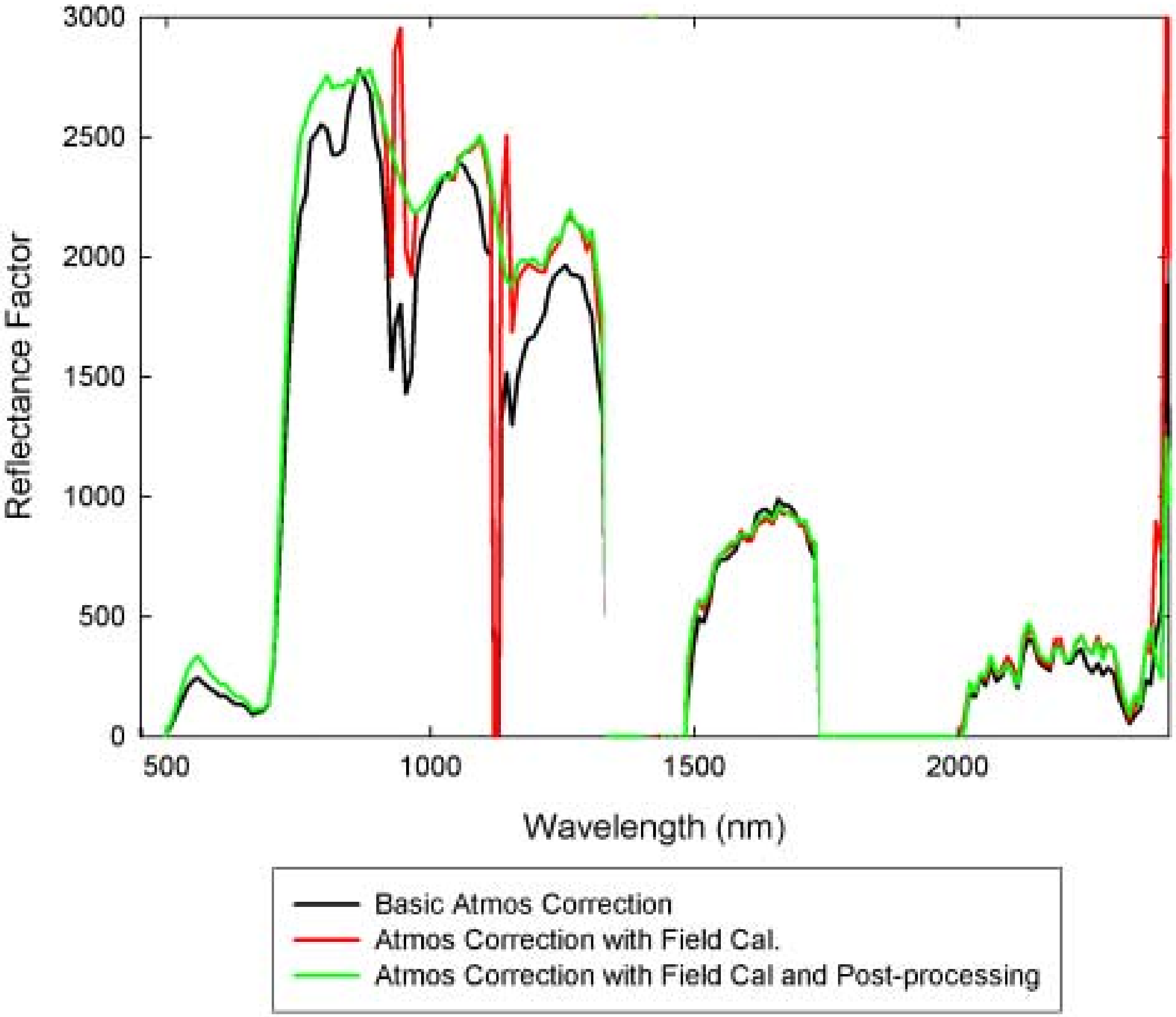
AVIRIS-30m



Hyperion



Typical Tropical Forest Reflectance Spectrum from Processed EO-1 Hyperion Imagery in the Amazon

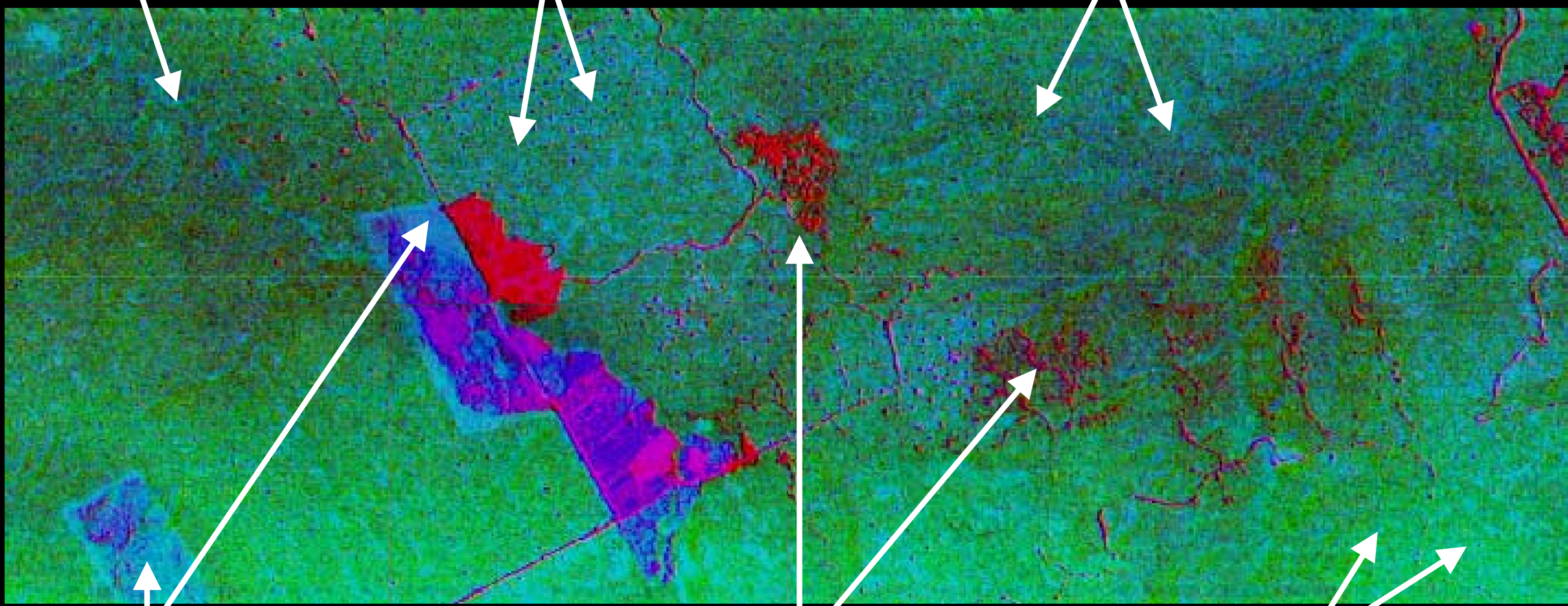


Forest Structure and Chemistry in the Brazilian Amazon from EO-1 Hyperion

Riparian Forest (Very High Canopy H_2O)

2 Yr Old Forest Regrowth (Mod. LAI, High Canopy H_2O)

4 Yr Old Forest Regrowth (High LAI, High Canopy H_2O)



Green Pasture Areas (High LAI/H_2O)

New Logging (High Slash and Soil)

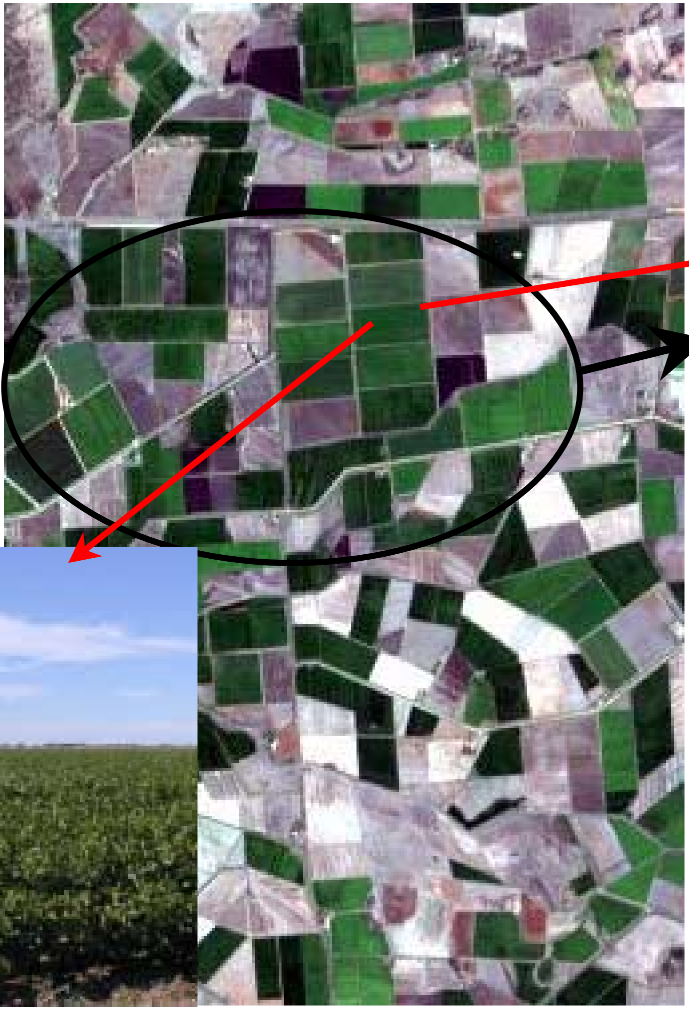
Primary Forest (High LAI, Mod. Canopy H_2O)

Litter/Slash and Soil | Leaf Area | Canopy Water

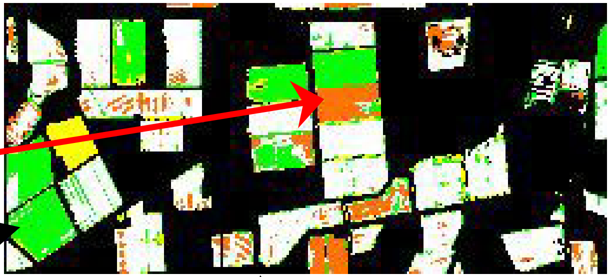
Kakadu
Lake Argyle
Cooper Creek
Cape Tribulation
Daintree
Batt Reef
Mossman
Townsville Reef
Port Hedland
Goldsworthy
Panorama
Kunoth
Amburla
Lake Eyre
Moreton Bay
Mt Fitton*
Tinga tingana
Toolabin
EOC Hyperspectral Sites
*Uardry
Lake George
Majura Valley
*Kioloa
Tanjil Bren
EOC HS Task Sites
Hyperion Sites
* Potential 1st 60 days Sites
X band sites

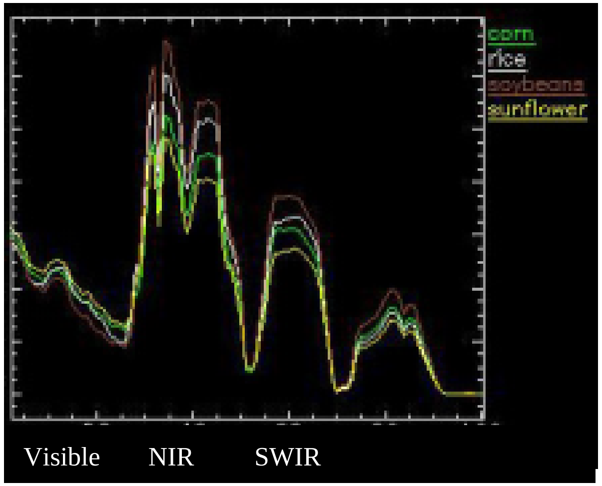
EO-1 Hyperion Distinguishes Crop Types

Detailed spectra allow greater potential for plant type identification than do multi-spectral data



Green - Corn
Brown - Soybean
White - Rice
Yellow- Sunflower

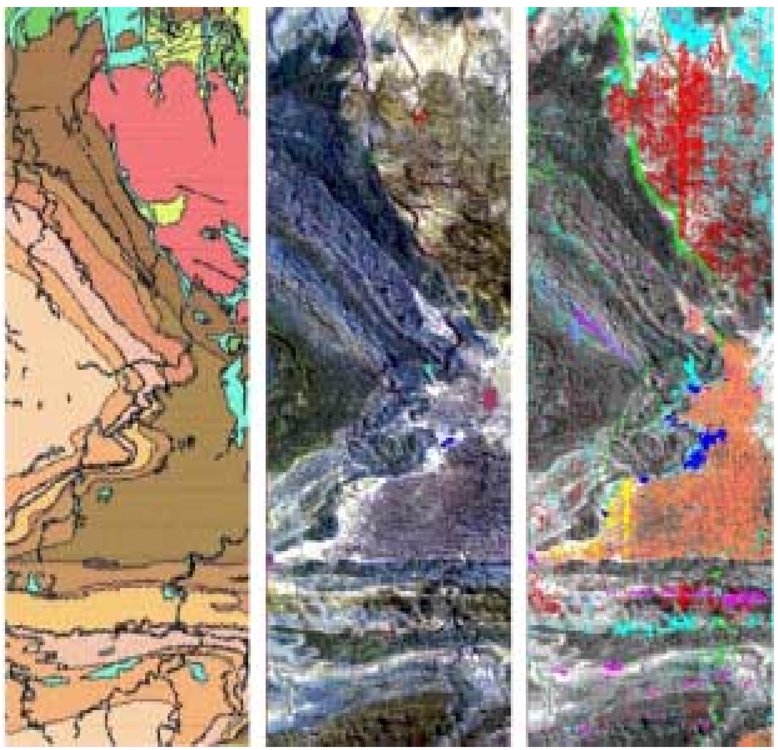




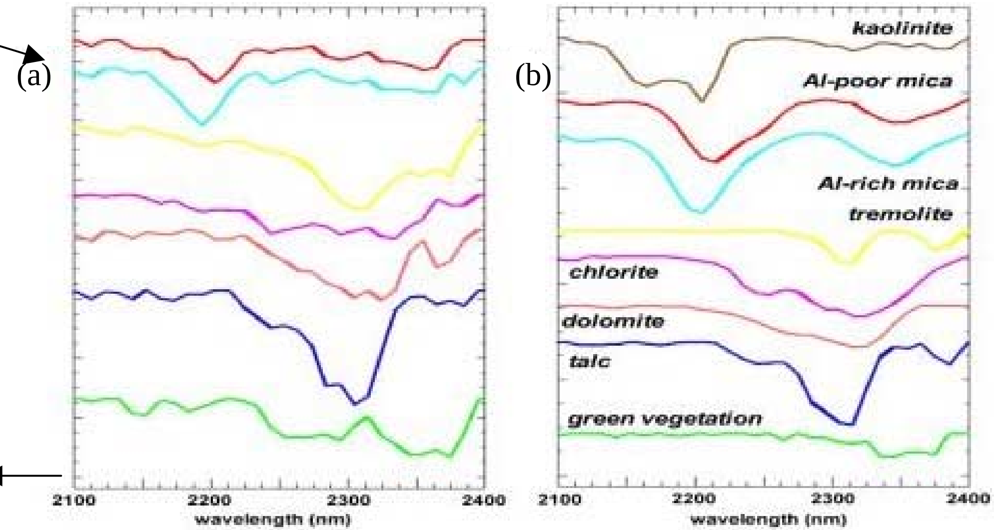
Hyperion Maps Mt. Fitton Geology

Hyperion-based apparent reflectance compares with library reference spectra

(1) (2) (3)



Hyperion Spectra **Reference Spectra**



Hyperion surface composition map agrees with known geology of Mt. Fitton in South Australia

(1) Published Geologic Survey Map

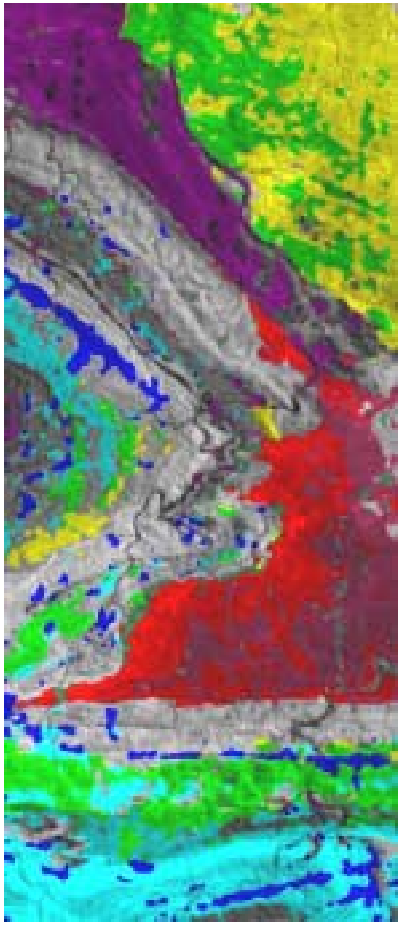
(2) Hyperion three color image (visible) showing regions of interest

(3) Hyperion surface composition map using SWIR spectra above

EO-1 Hyperion Maps Mt. Fitton Geology

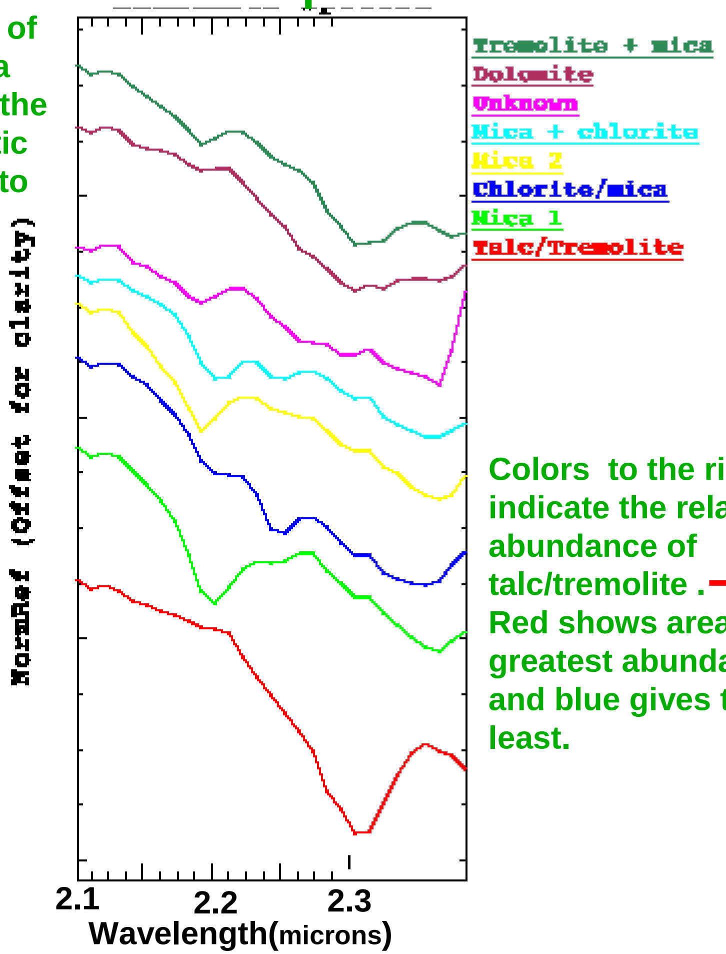
Automatic mineral mapping algorithm creates, in 30 seconds, a quick-look mineral map (left). More precise detail is on right.

Mineral Map



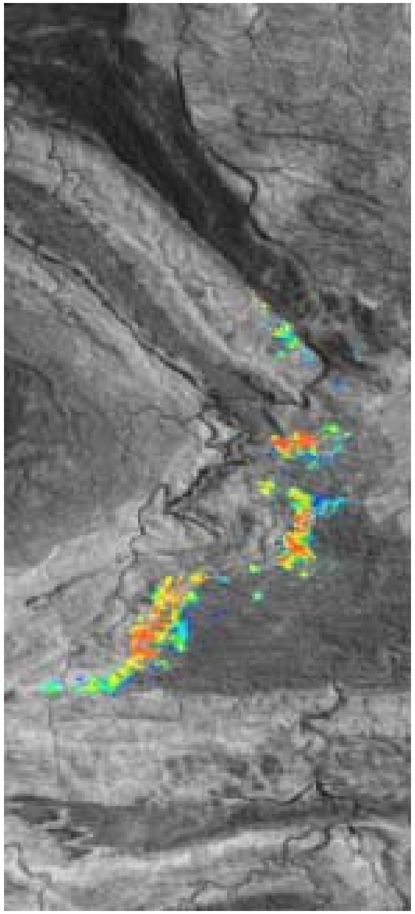
Colors of spectra match the thematic image to left.

Mineral Spectra



Colors to the right indicate the relative abundance of talc/tremolite . Red shows areas of greatest abundance and blue gives the least.

Detailed Talc-Tremolite Map



Views with the EO-1 ALI Pan band