Summary of EO-1 Science Team Activities

Phil Townsend

University of Maryland Center for Environmental Science
Appalachian Laboratory

LCLUC Temperate and Boreal Workshop
October 31, 2001

Real Credit

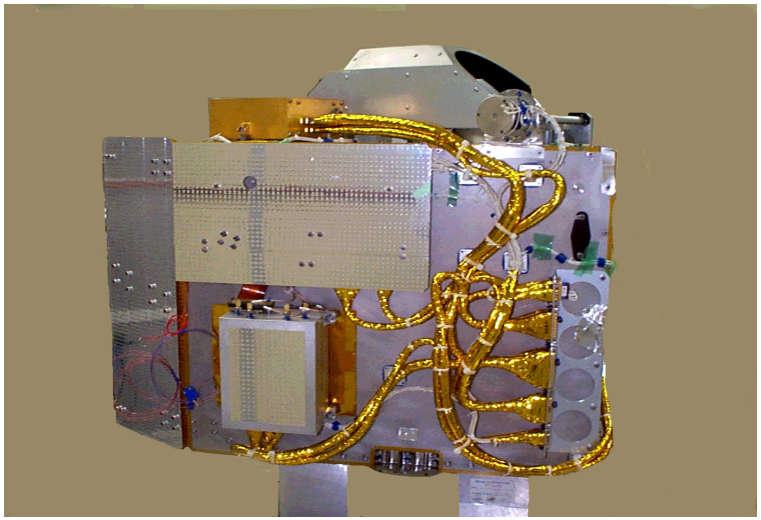
Stephen Ungar
EO-1 Mission Scientist
Biospheric Sciences Branch

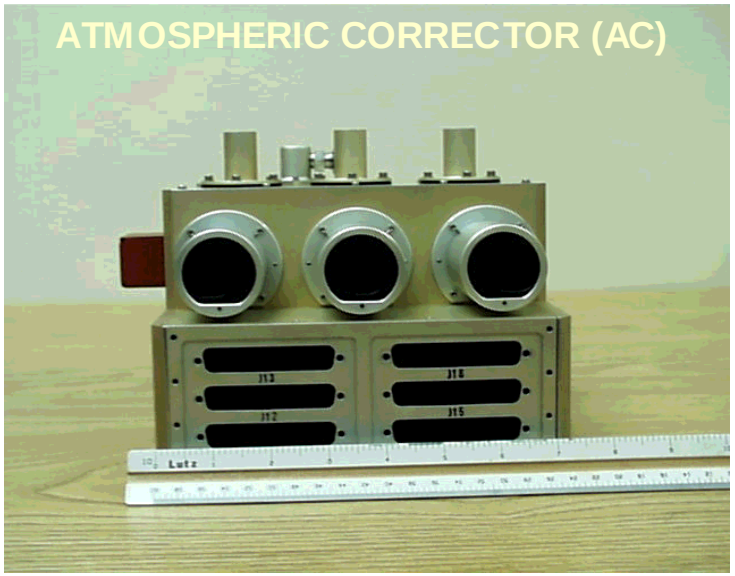
plus all the EO-1 SVT Members

Role of EO-1 SVT

Science Validation Team
Evaluates Performance of
EO-1 Flight Instruments

HYPERION





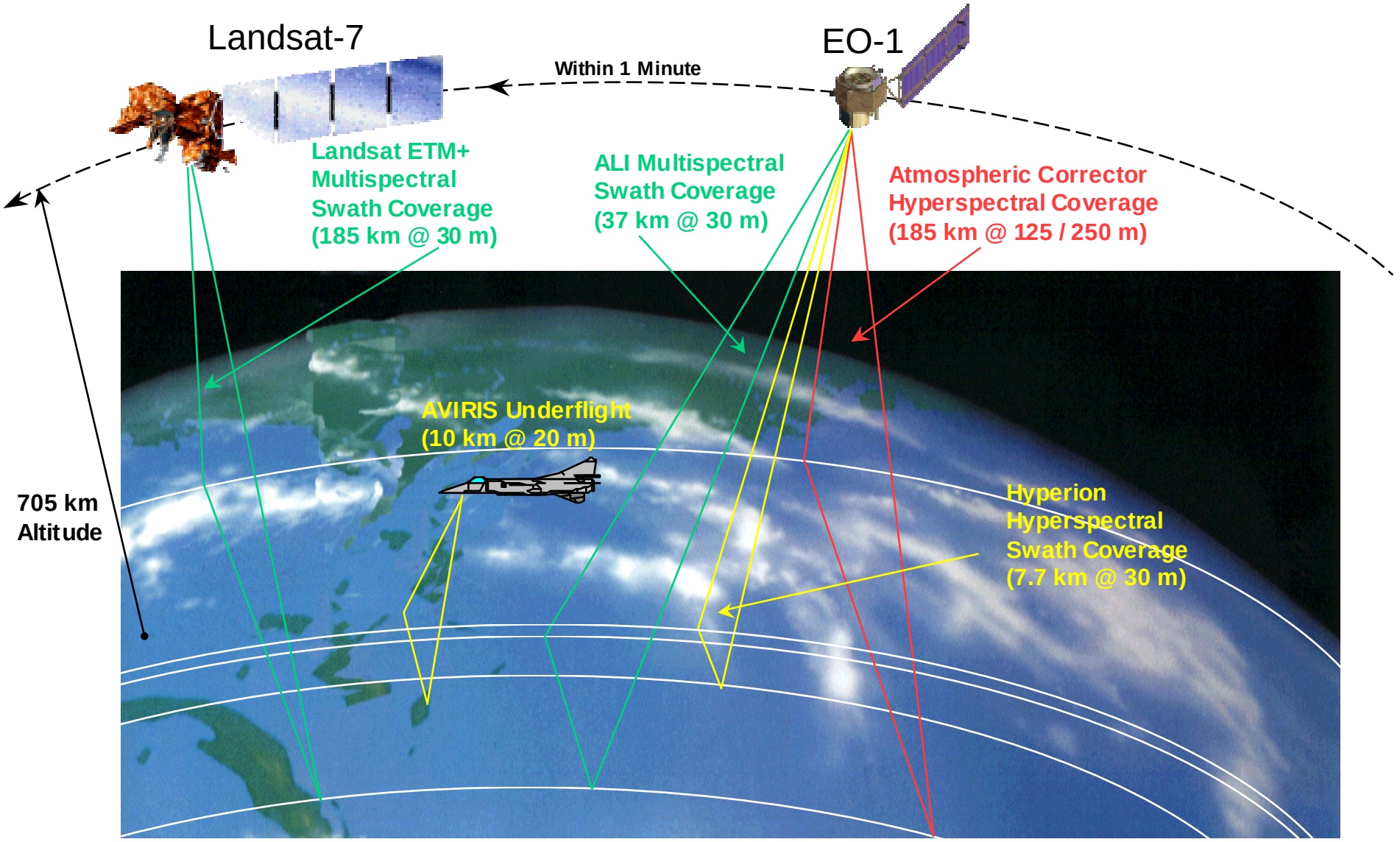
Science Validation Team

- **Instrument Team**
  - **Validate/re-establish and refine pre-launch characterizations**
  - **Provide technology validation**
  - **Participate on Science Validation Team**

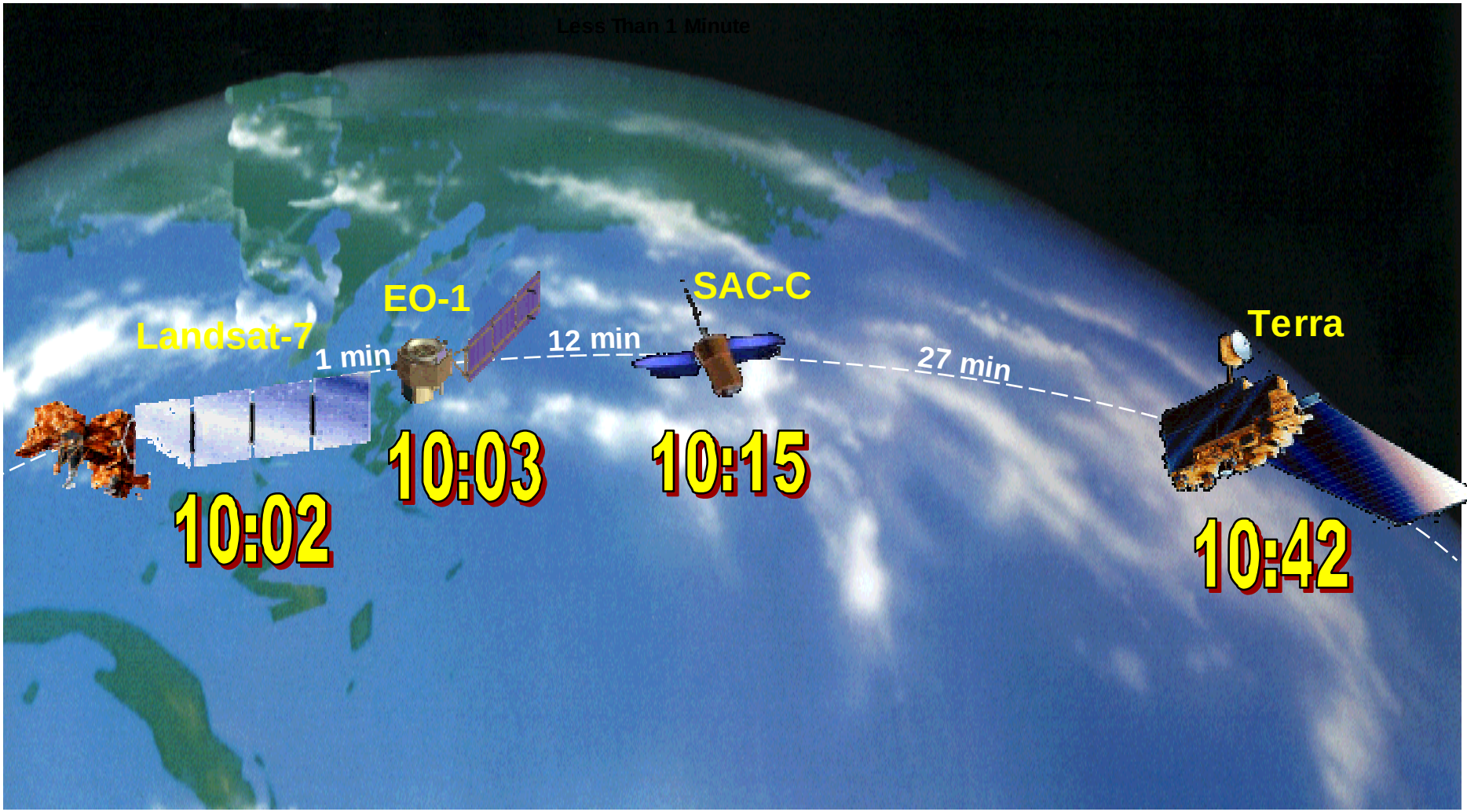
- **NASA Science Validation Team**
  - **Conduct scene based instrument performance characterizations**
  - **Measure ability of instruments to make Landsat-like observations**
  - **Assess capability for addressing earth remote sensing applications**
  - **Assist in technology validation**
  - **Facilitate Commercial Applications (CRSP/SSC)**

- **International Collaborators**
  - **Argentina, Australia, Canada, Italy, Japan, Singapore**

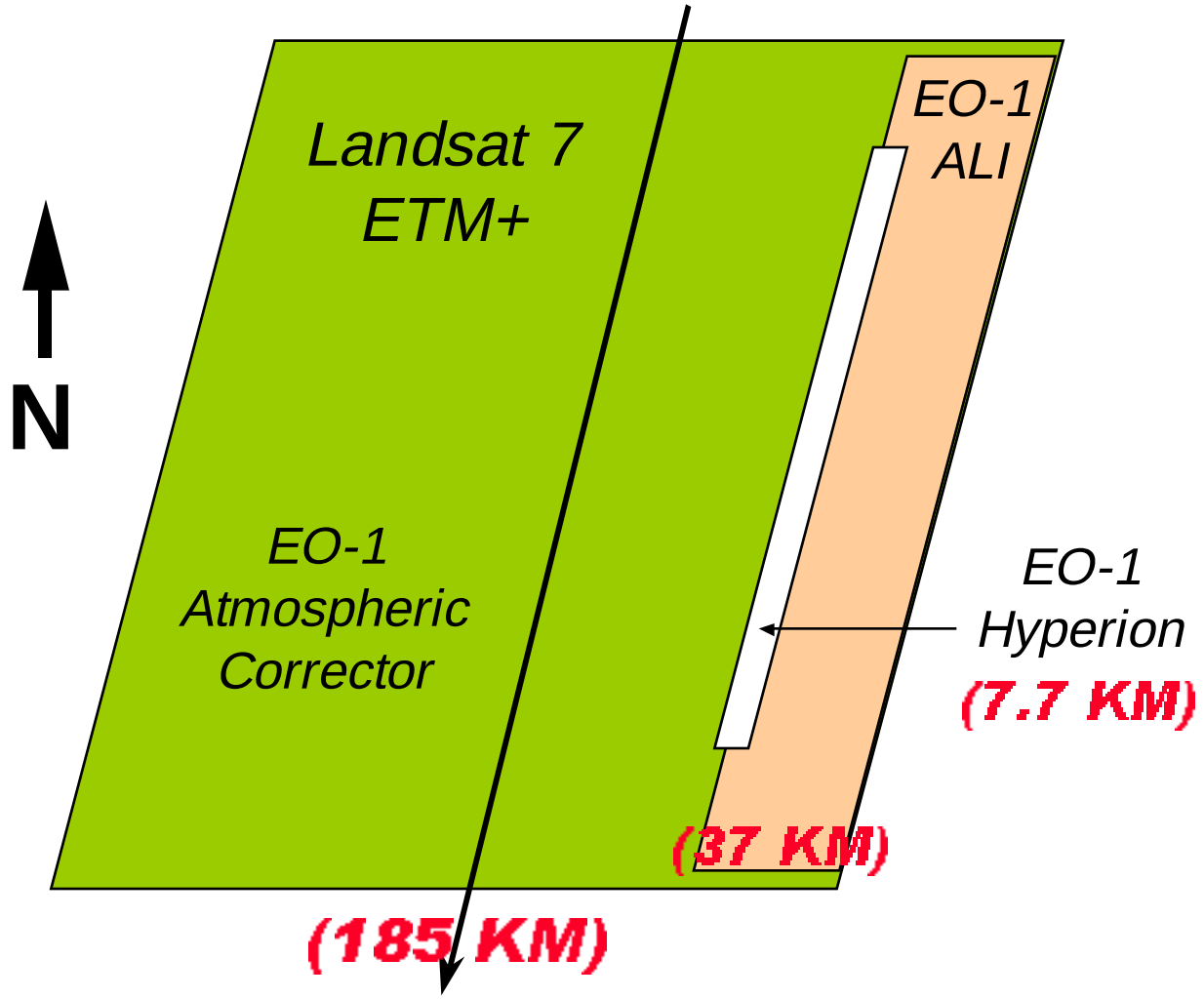
EO-1 and Landsat



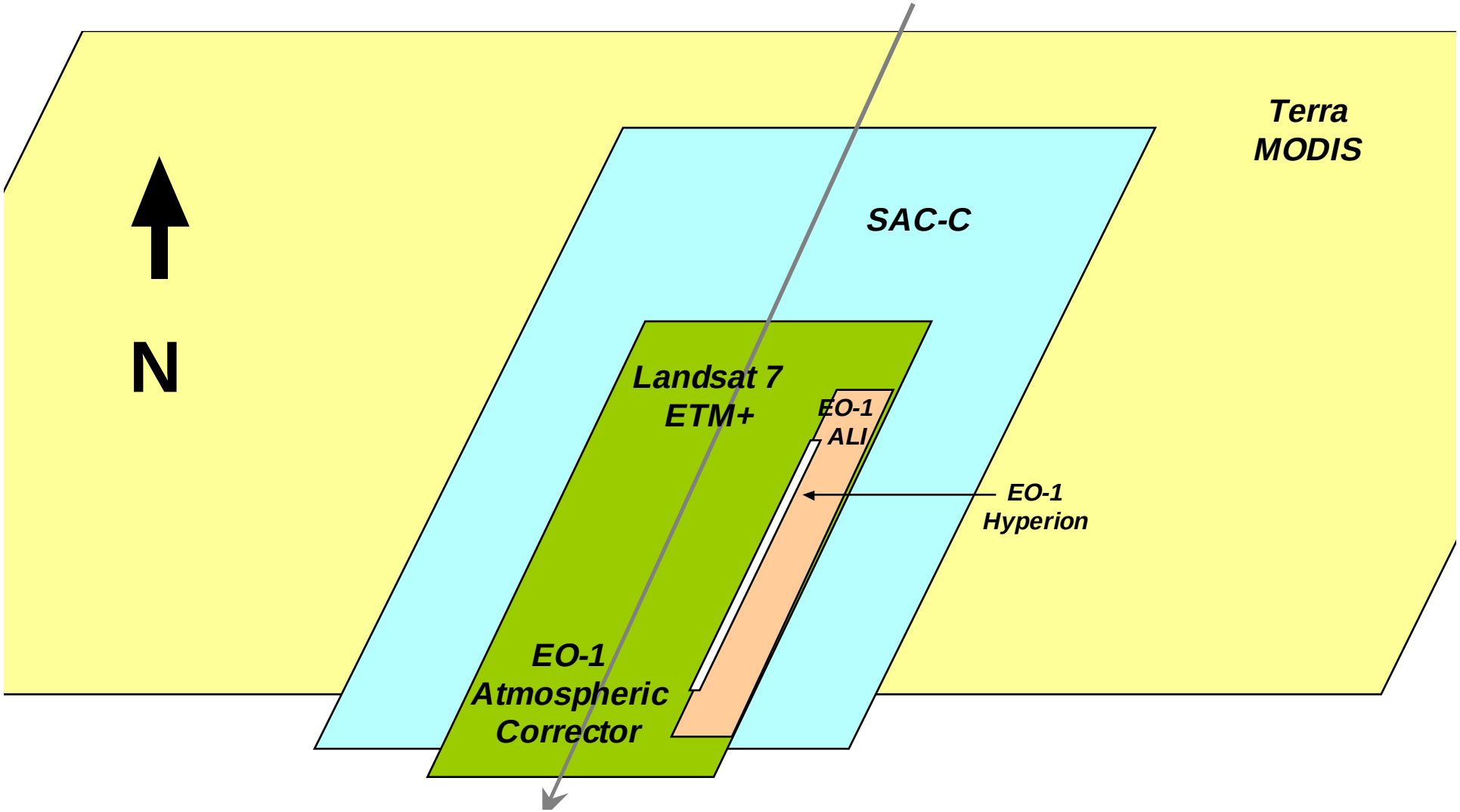
The EOS AM Constellation Alignment



EO-1 and Landsat 7
Descending Orbit Ground Tracks



AM Constellation Descending Orbit Ground Tracks

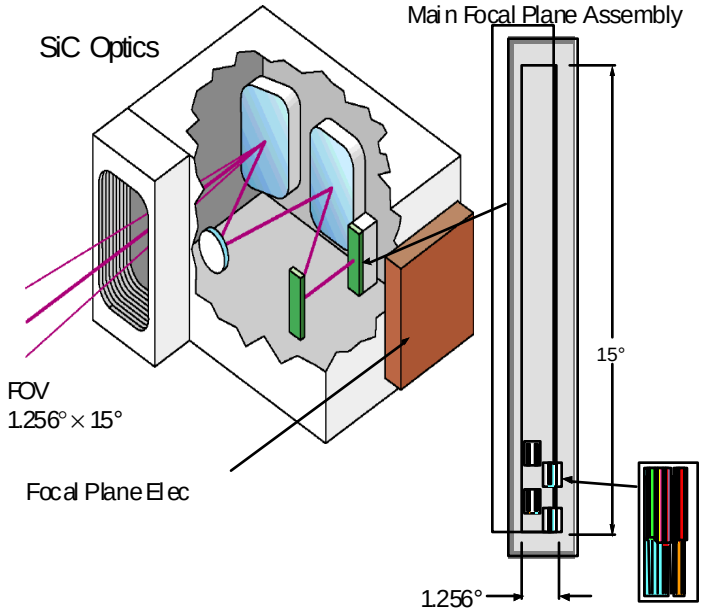


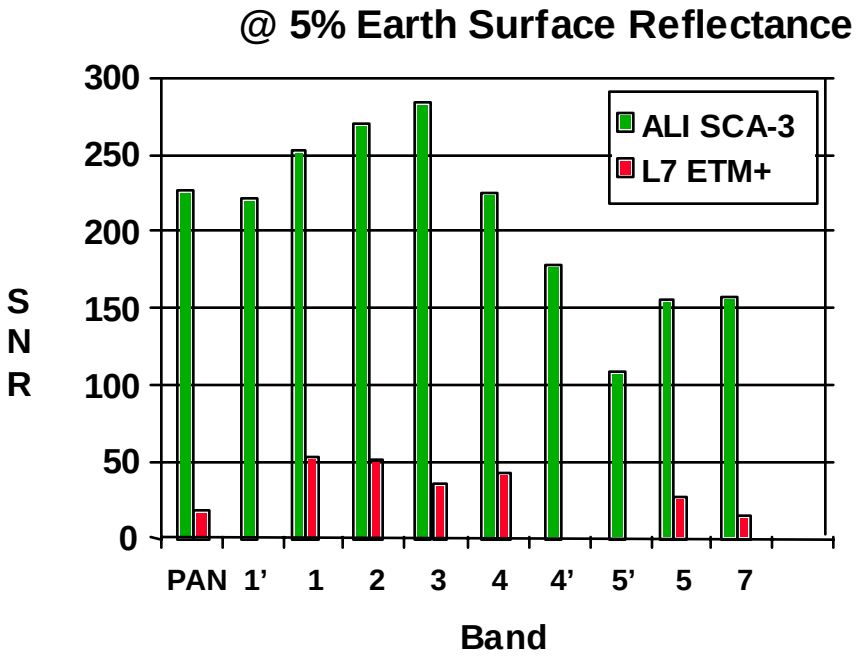
EO-1 Instrument Overviews

Parameters	Landsat 7	EO-1	EO-1	
	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	7.7 Km	185 Km
Spectral Resolution	Variable	Variable	10 nm	4 - 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*

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

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)

EO-1 Instrument Overviews

Parameters	Landsat 7 ETM+	EO-1 Multispectral	EO-1 HYPERION	EO-1 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	3 Km	7.7 Km	185 Km
Spectral Resolution	Variable	Variable	10 nm	4 - 9 nm**
Spectral Coverage	Discrete	Discrete	Continuous	Continuous
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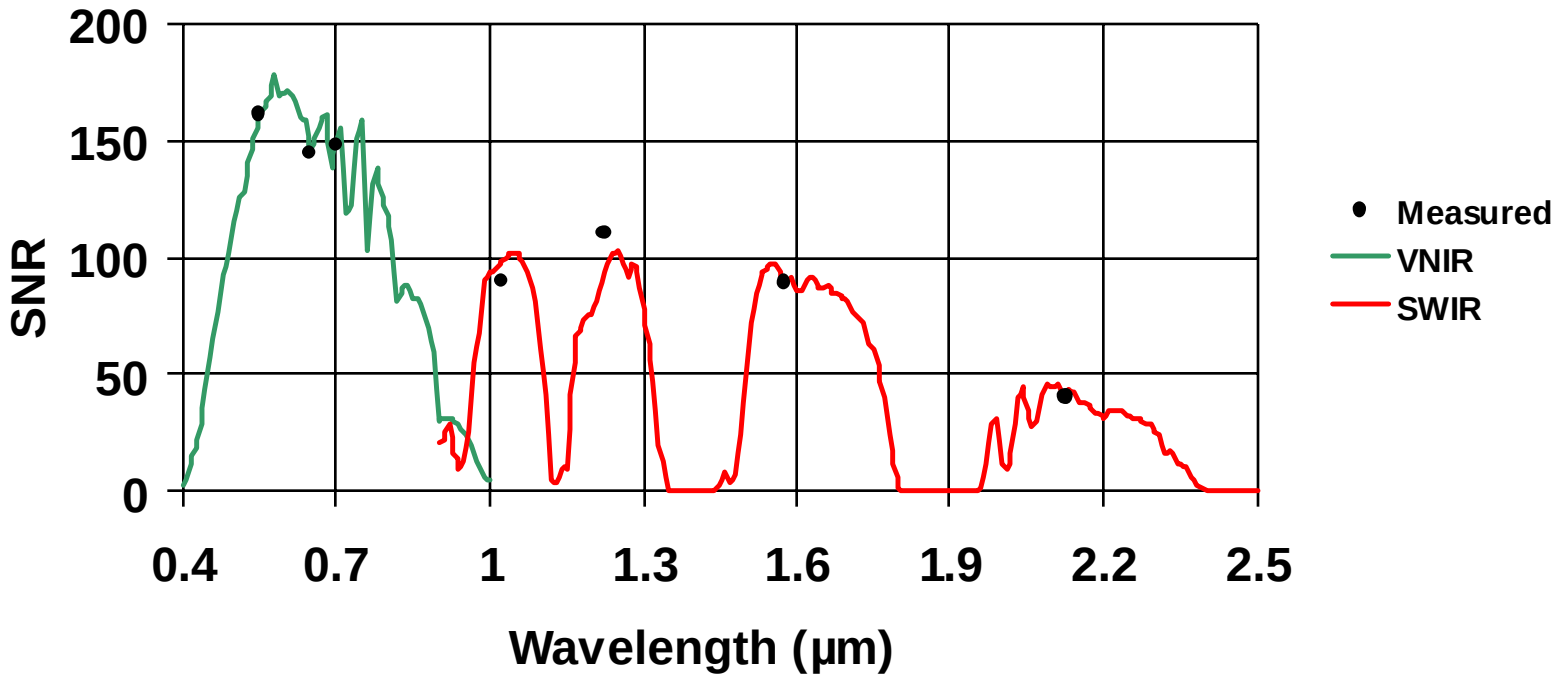
*** 35/55 cm^{-1} constant resolution*

Hyperspectral Analysis derives from the use of contiguous spectral channels, allowing the use of derivatives and sophisticated analysis techniques. The large number of bands allows more complex systems to be addressed without the under sampling inherent in multispectral systems.

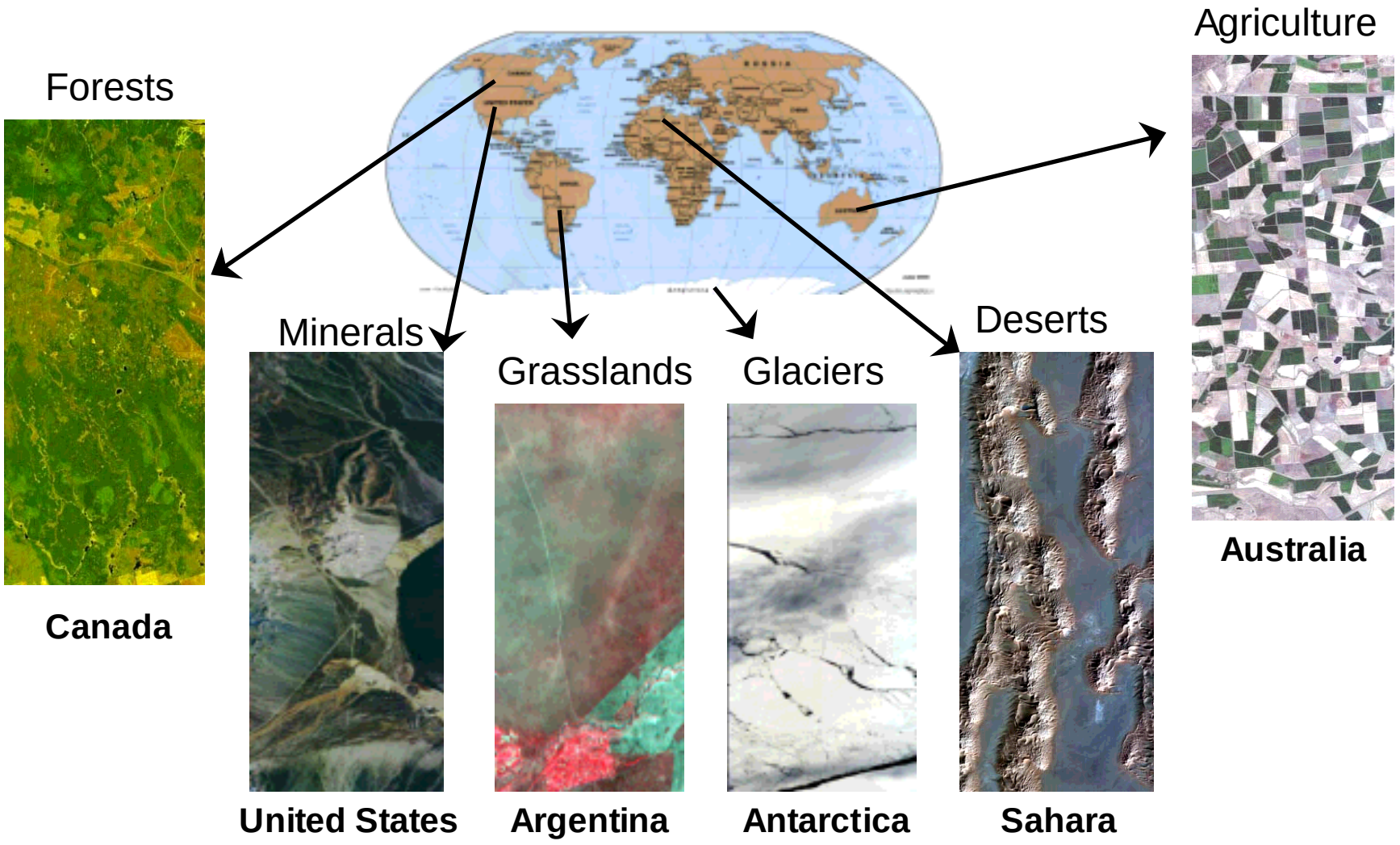
Hyperion S/N Performance

Radiometric performance model base on 60^{o} 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

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



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)

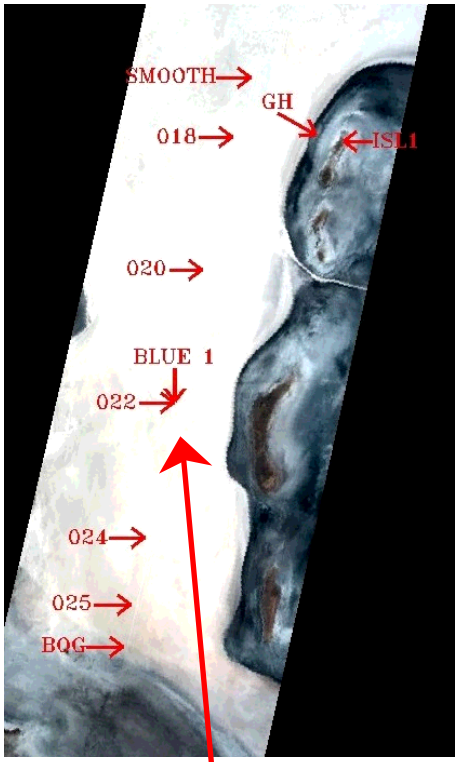
Research Topic	Principal Investigator
Ecological Applications in Yellowstone National Park	Boardman, J. W., AIG, **Colorado**
Commercial Applications	Cassady, P. E., **Boeing, Washington**
Radiometric and Spatial Evaluation of ALI and Hyperion	Biggar, S. F., **University of Arizona**
Atmospheric Correction	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**

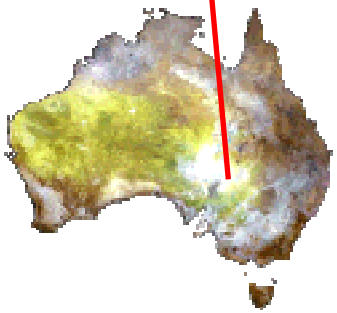
Investigator Research Topics (continued)

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**

Desert Sites used for Vicarious Calibration

Lake Frome





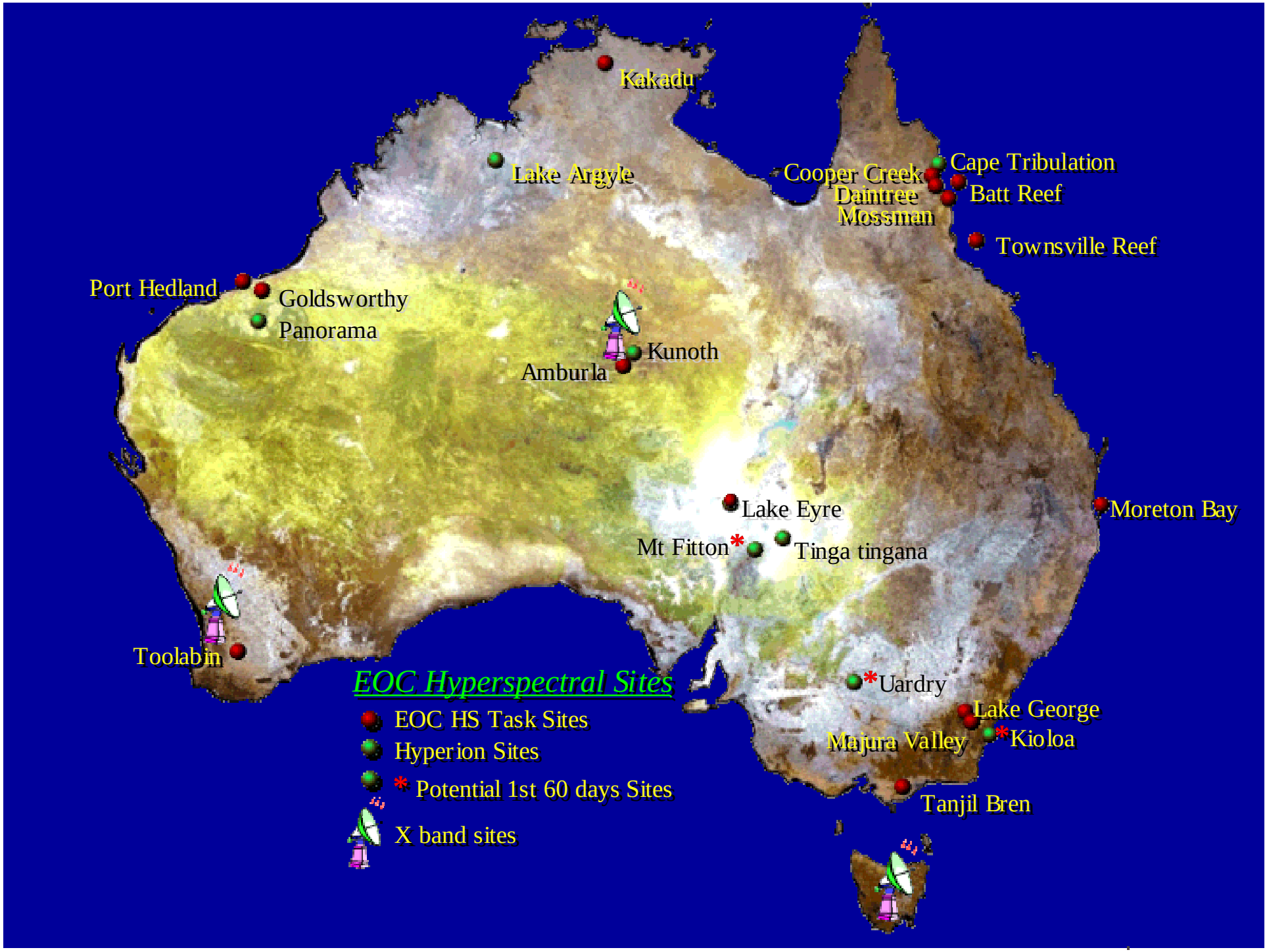
RR Valley

Arizaro/Barreal Blanco

Of Note

Southern Hemisphere Field Campaigns

- Australia
- Argentina
- Brazil
- Bolivia
- New Zealand

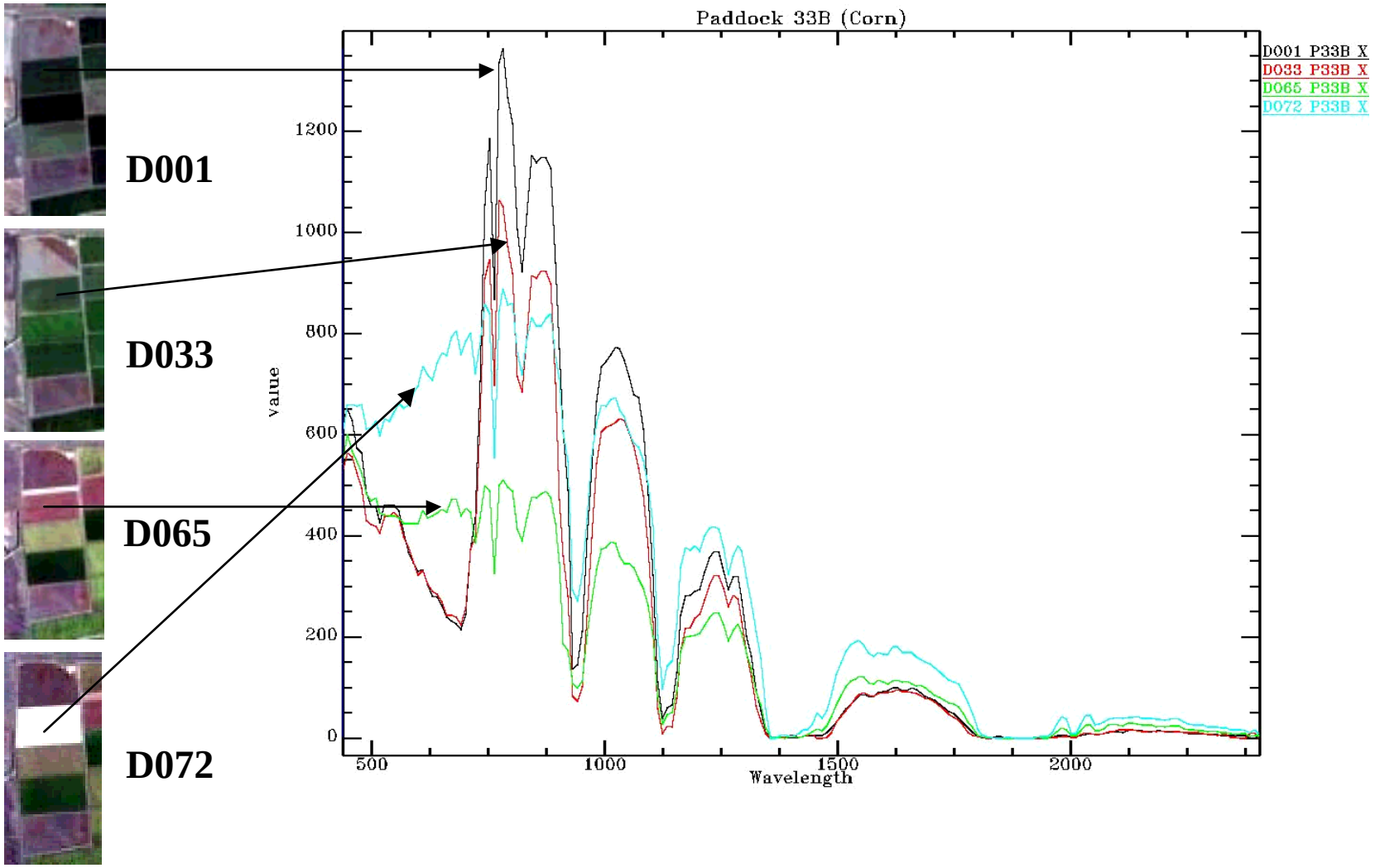

Kakadu
Lake Argyle
Cooper Creek
Cape Tribulation
Daintree
Batt Reef
Mossman
Townsville Reef
Port Hedland
Goldsworthy
Panorama
Kunoth
Amburla
Lake Eyre
Moreton Bay
Mt Fitton*
Tinga tingana
Toolabin
EOC Hyperspectral Sites
EOC HS Task Sites
Hyperion Sites
* Potential 1st 60 days Sites
X band sites
*Uardry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

Temporal Sequence of Hyperion Images Coleambally Irrigation Area

Jay Pearlman, TRW

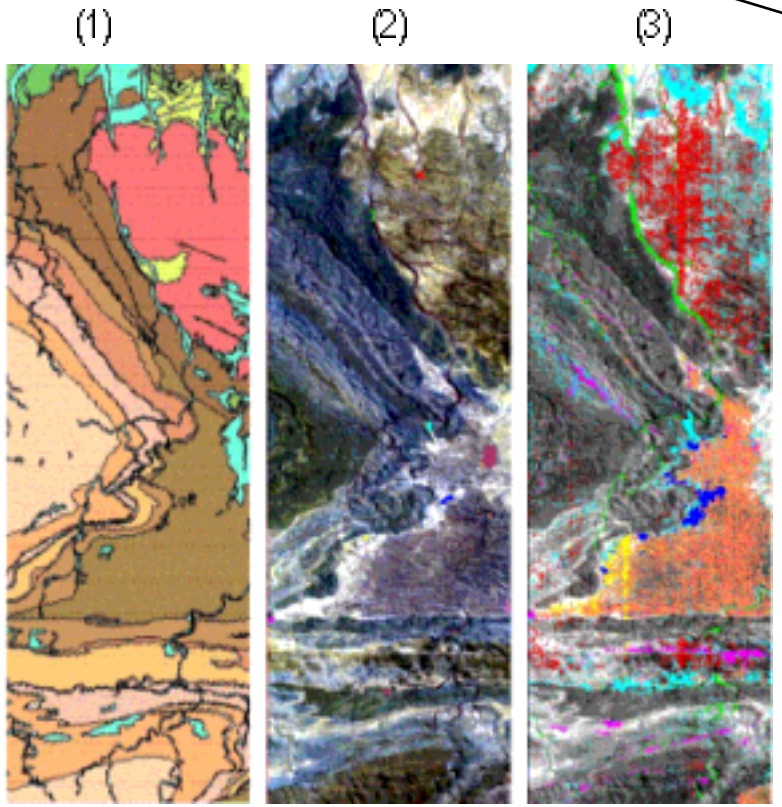
Julian calendar day of 2001

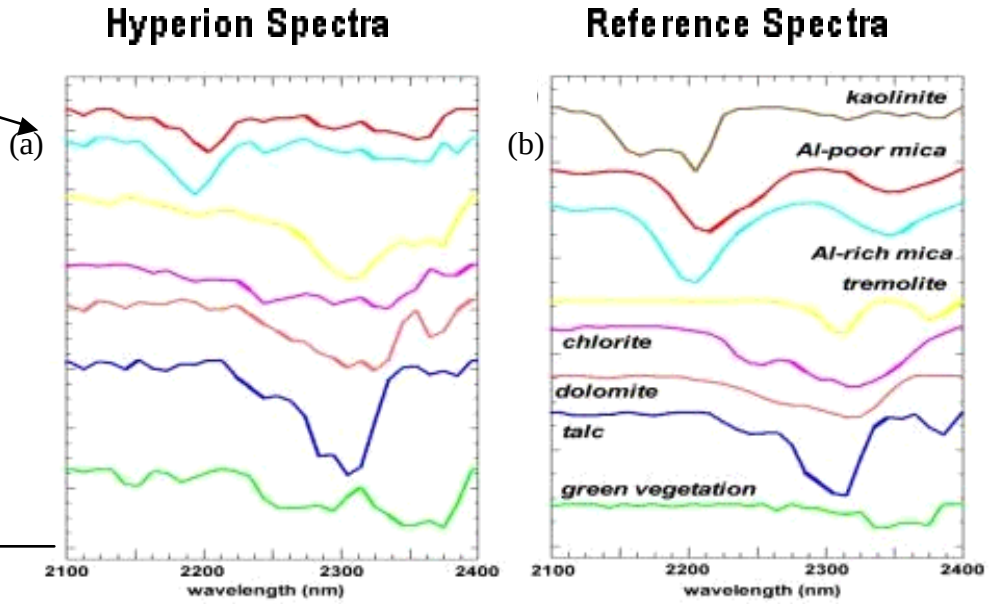
Corn (Paddock 33B)



Hyperion Maps Mt. Fitton Geology

Hyperion-based apparent reflectance compares with library 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

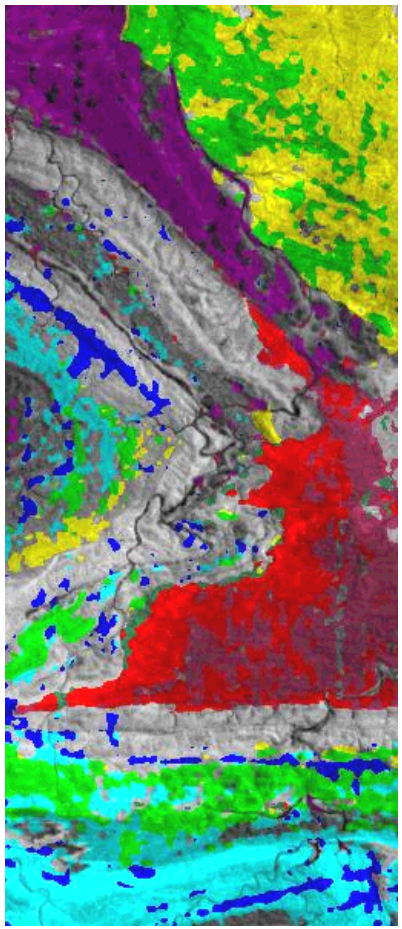
(3) Hyperion surface composition map using SWIR spectra above

Courtesy of CSIRO, Australia

Hyperion Maps Mt. Fitton Geology

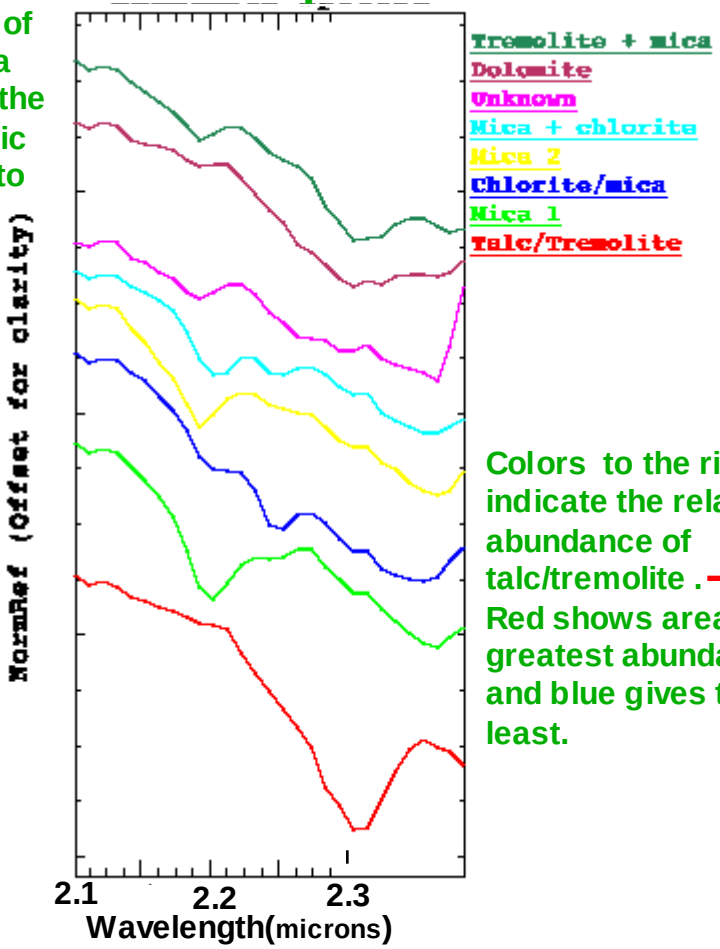
Automatic mineral mapping algorithm creates, in 30 seconds, a quick-look mineral map (left & centre). More precise detail is on right. (Courtesy of CSIRO Australia)

Mineral Map



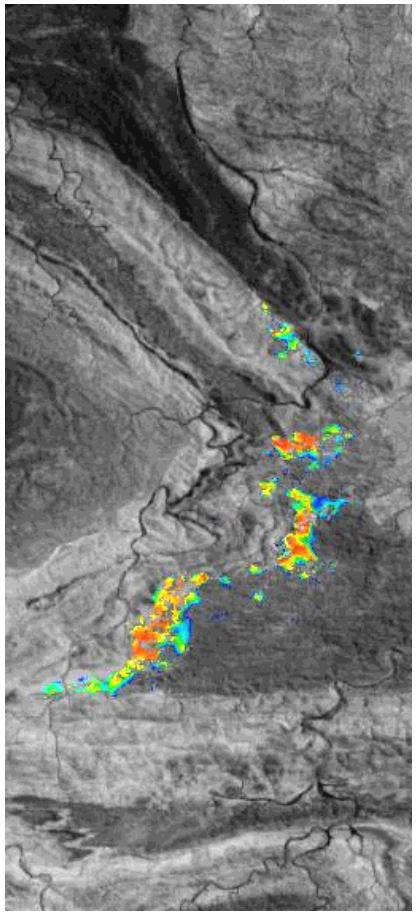
Colors of spectra match the thematic image to left.

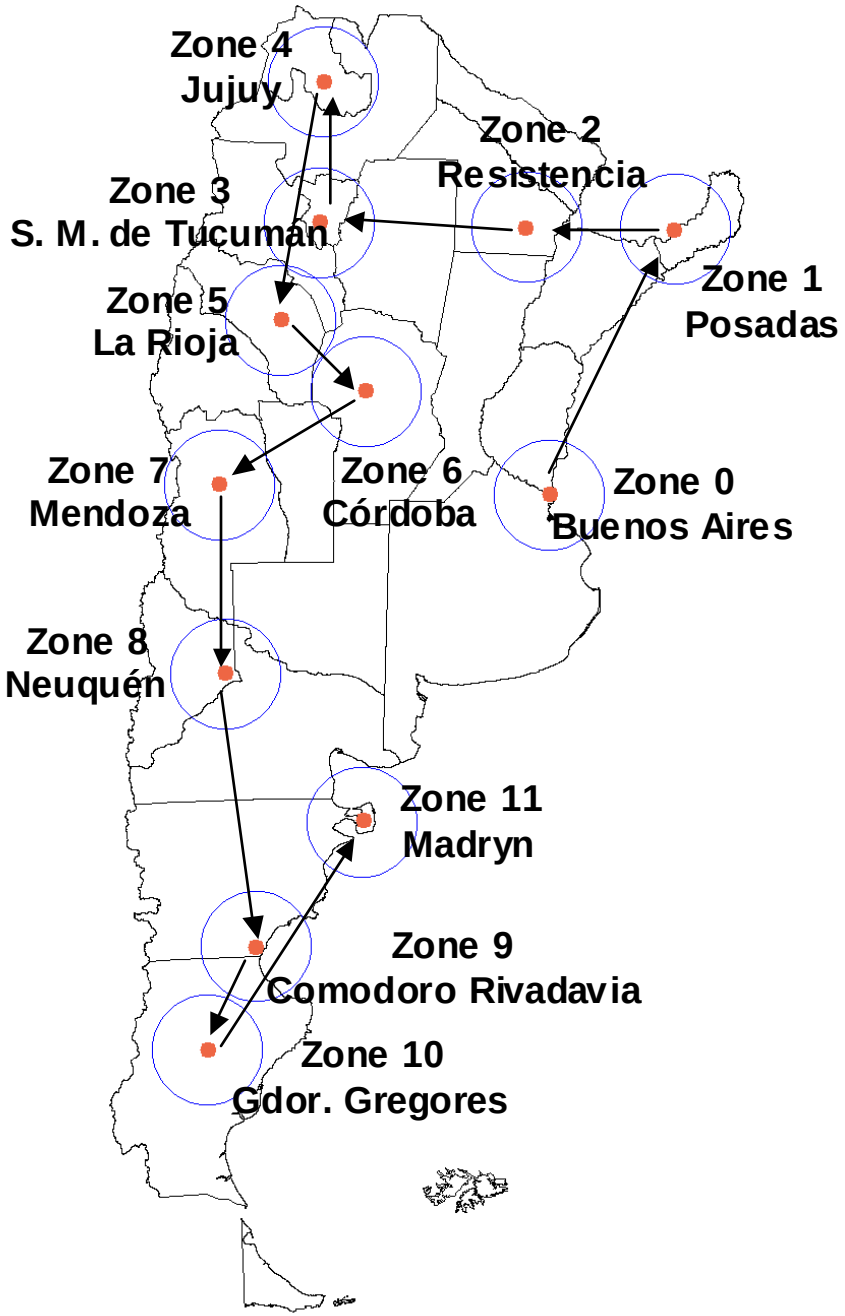
Mineral Spectra



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





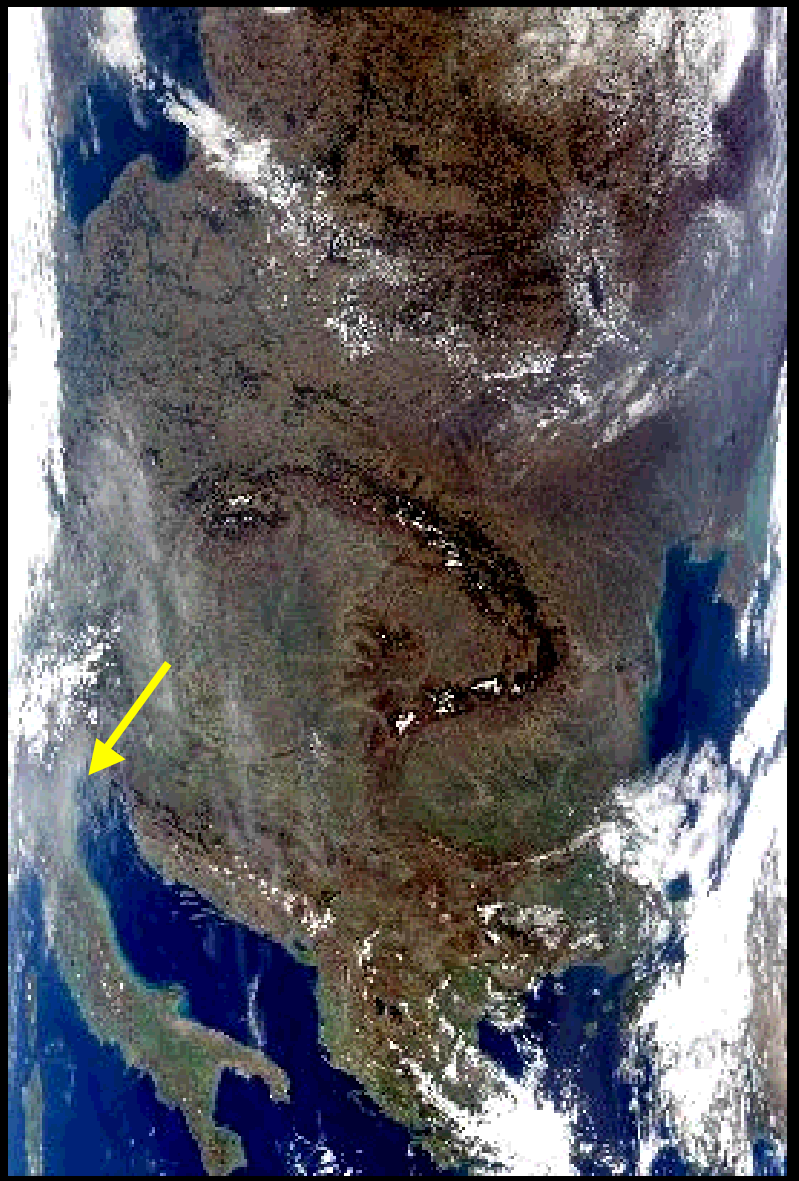
Argentina Validation Site Zone Map

for AVIRIS and EO-1/SAC-C overflights

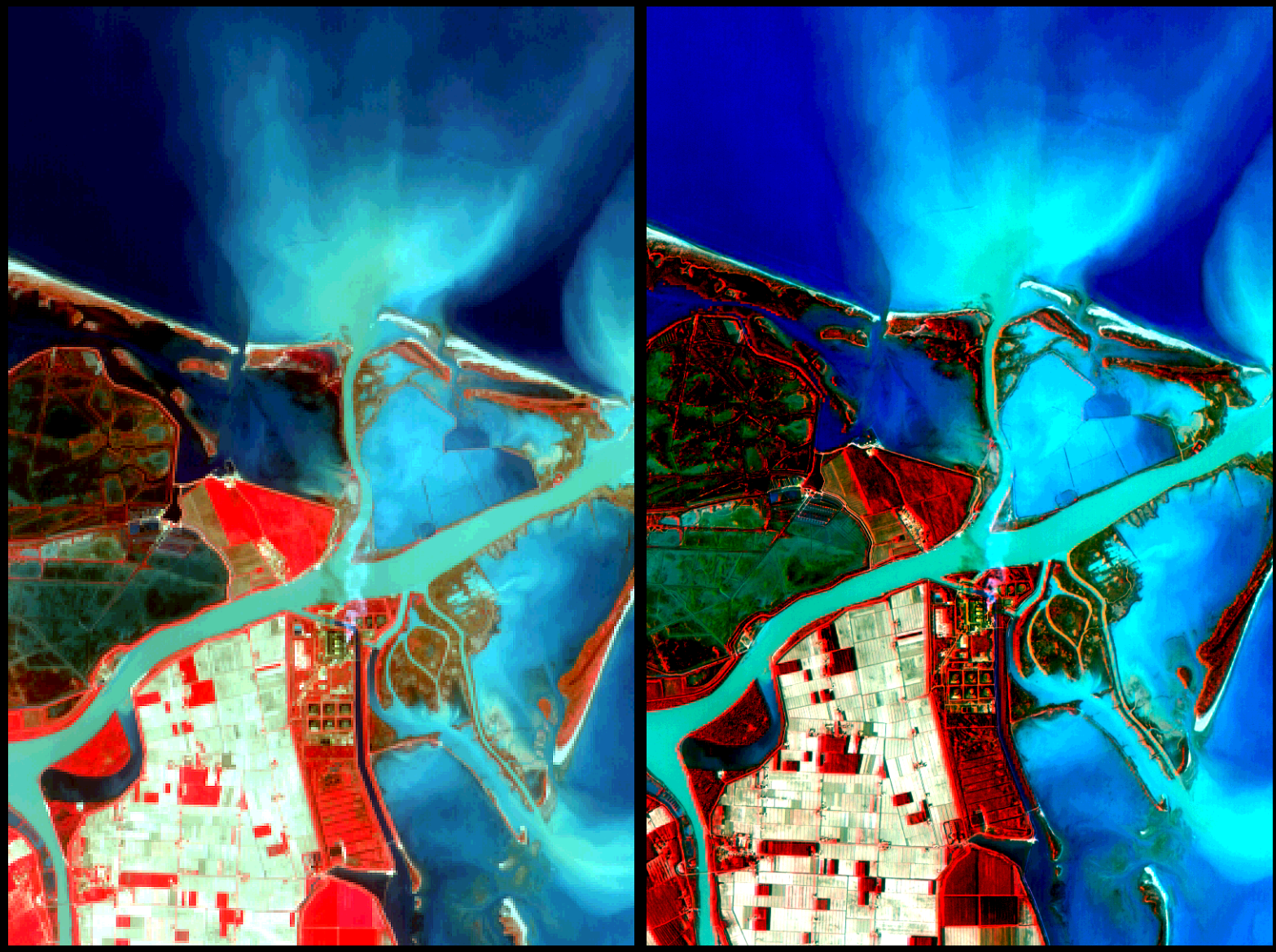
Water Quality / Pollution / Oceanography / Urban Applications

Venice, Italy

Michael Abrams
NASA/JPL



April 3, 2001 MODIS image

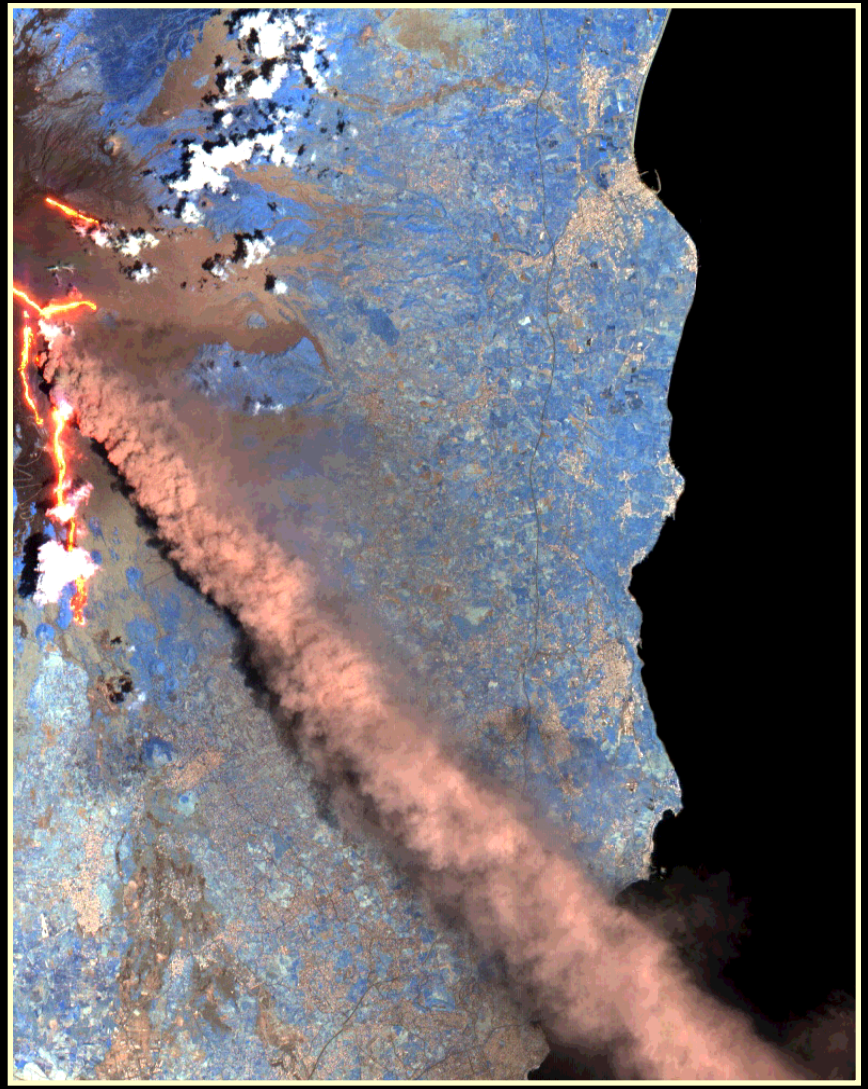


April 4, 2001 ALI 5-4-3 RGB image

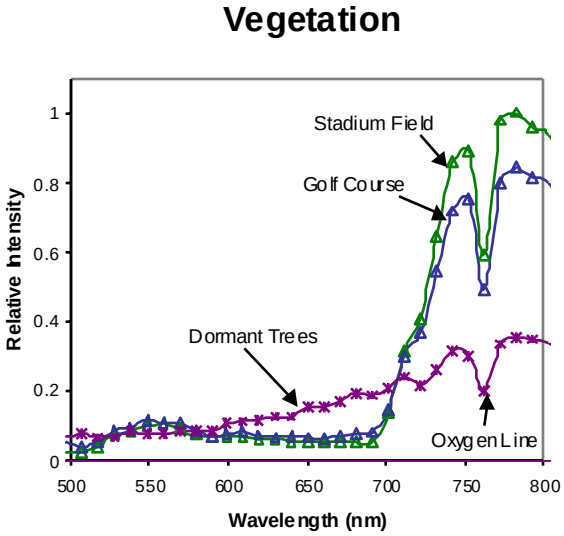
Mount Etna - July 22, 2001

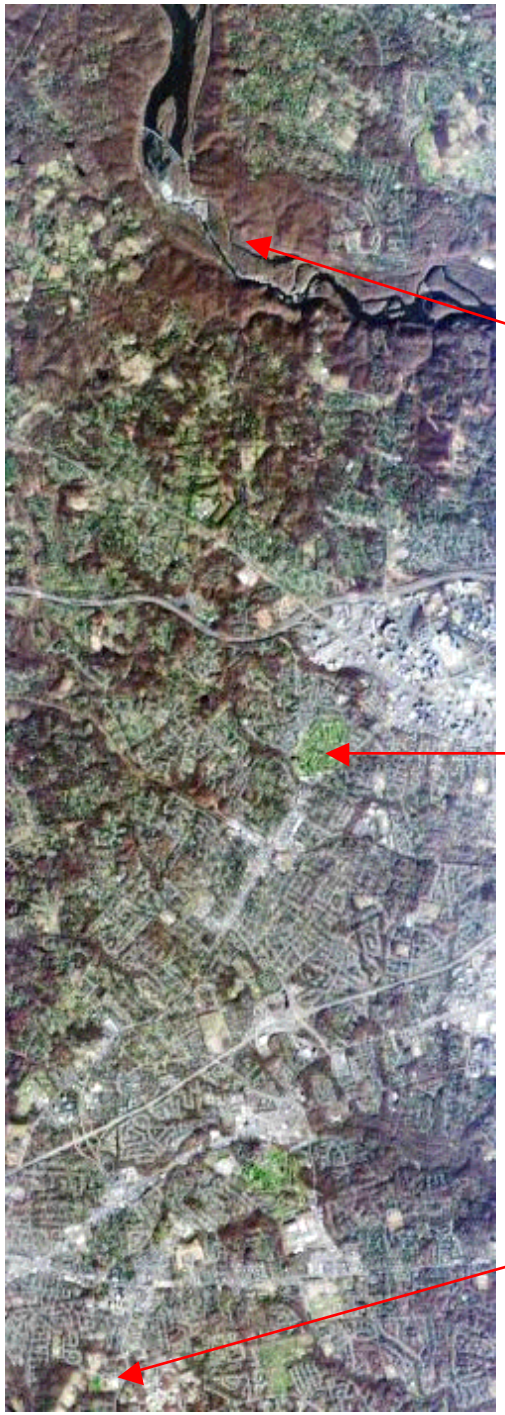
ALI Pan Enhanced 3-2-1

EO-1 ALI Bands 7-5-5’



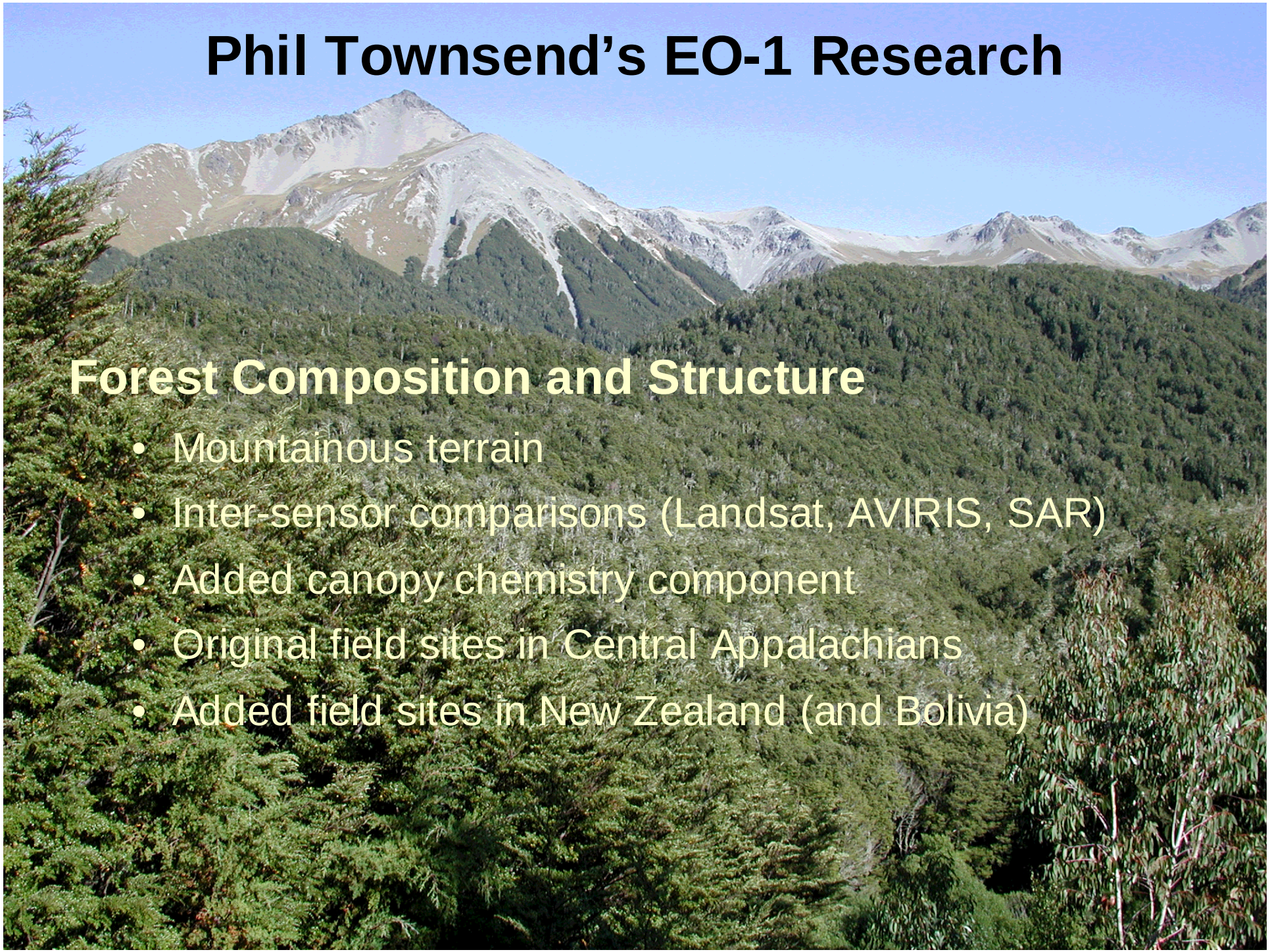
Hyperion
December 1, 2000





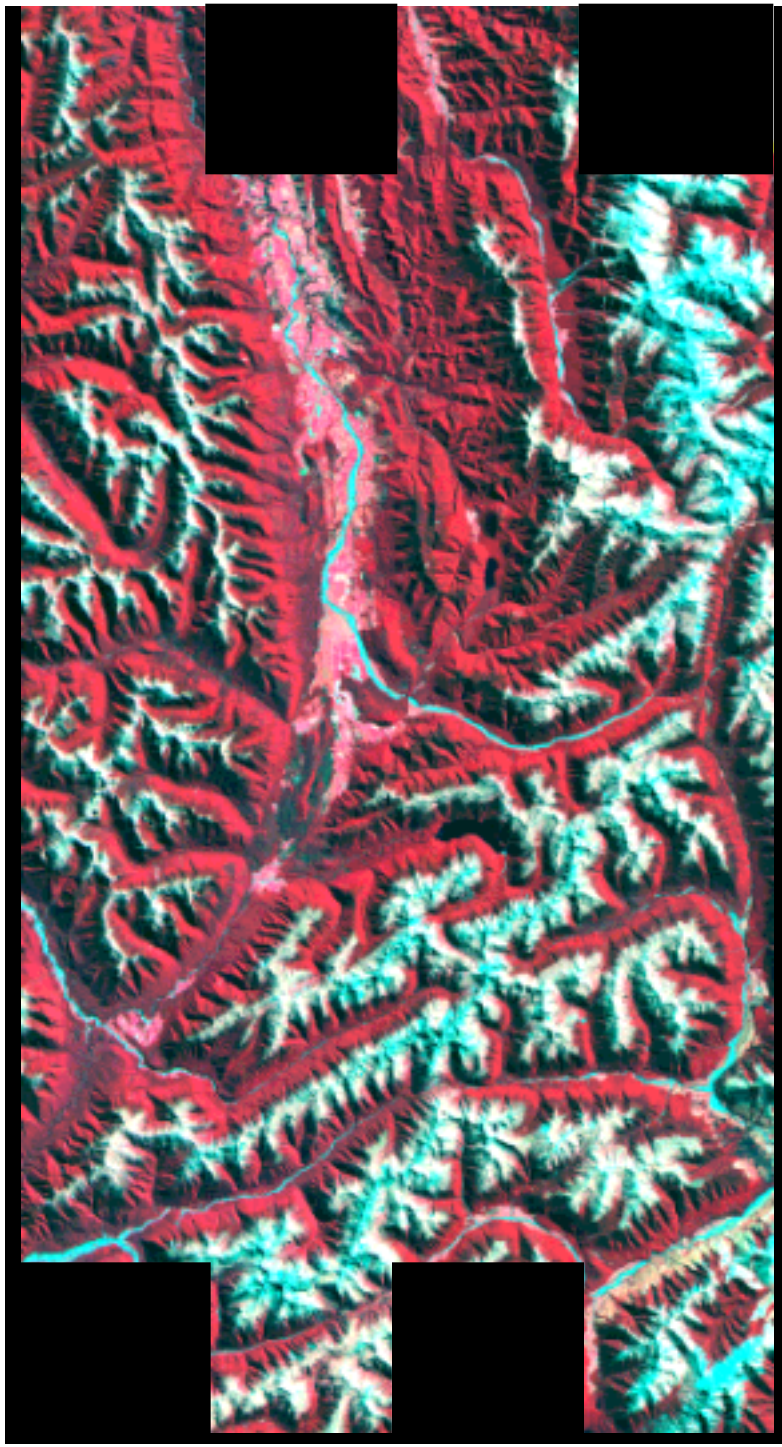
Courtesy of TRW Inc.

Phil Townsend's EO-1 Research



Forest Composition and Structure

- Mountainous terrain
- Inter-sensor comparisons (Landsat, AVIRIS, SAR)
- Added canopy chemistry component
- Original field sites in Central Appalachians
- Added field sites in New Zealand (and Bolivia)



Craigieburn (NZ) field site

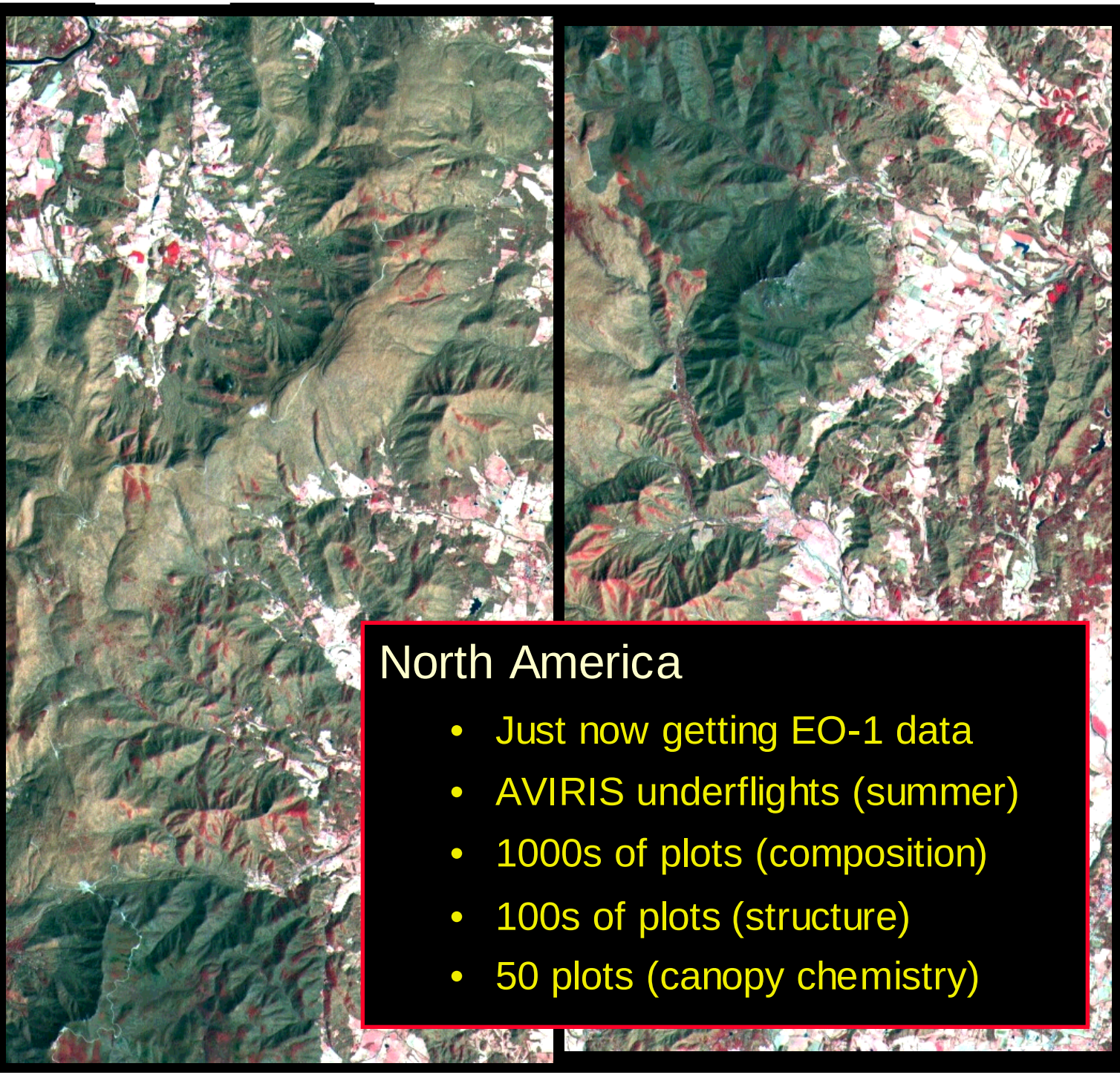
Naturally monospecific vegetation (mountain beech)

- > 200 collaborator plots
  Complete stem inventory estimates of biomass
- Canopy nutrients at 12 sites, 6 fertilized
- 40 additional plots in 2001
  - Measurements of cover, height, and canopy structure

Biomass: 83.9 – 342.5 Mg/Ha

Basal area: 24.0 – 82.8 m^2/Ha

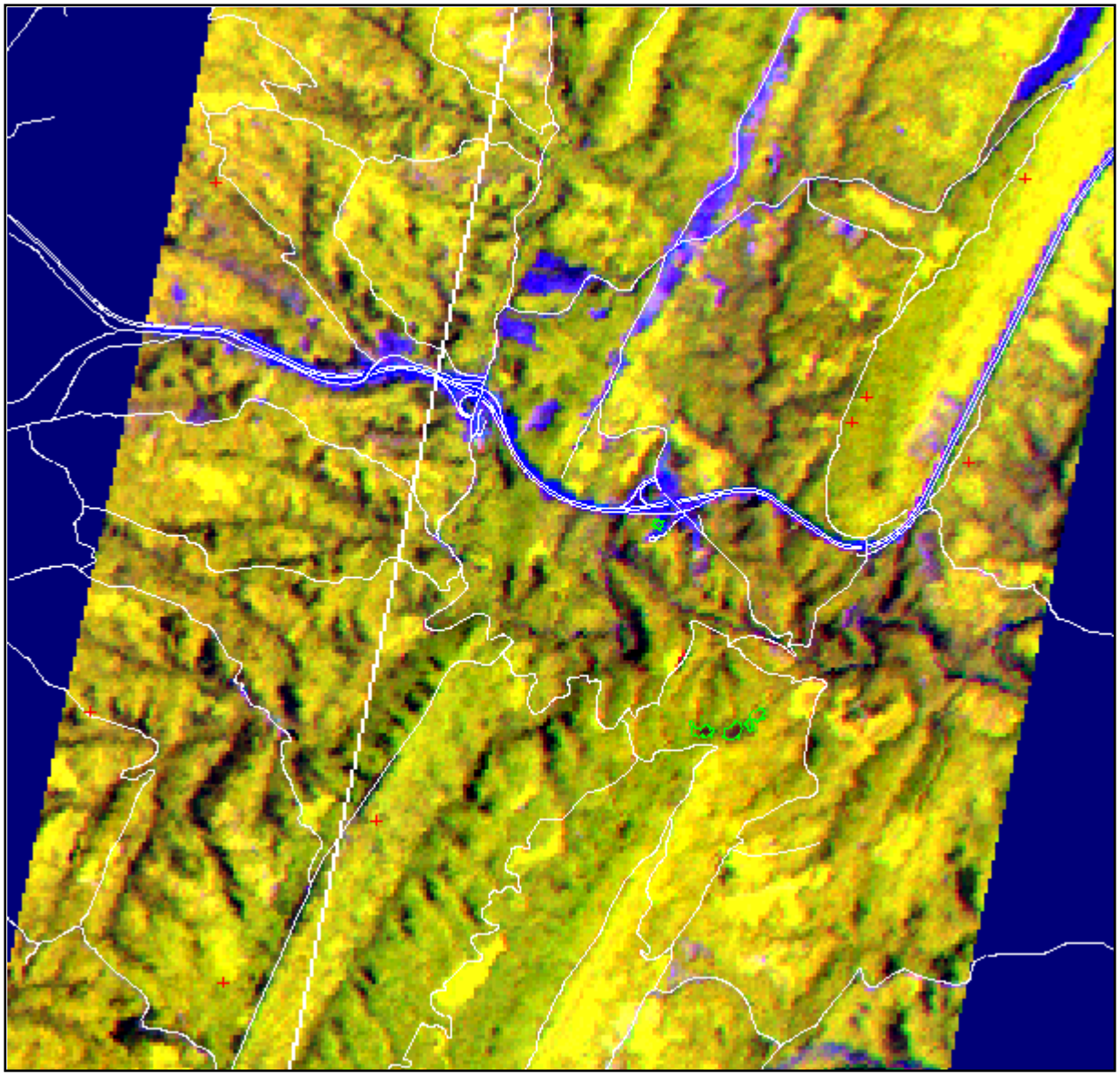
LAI: 2.3 – 5.5



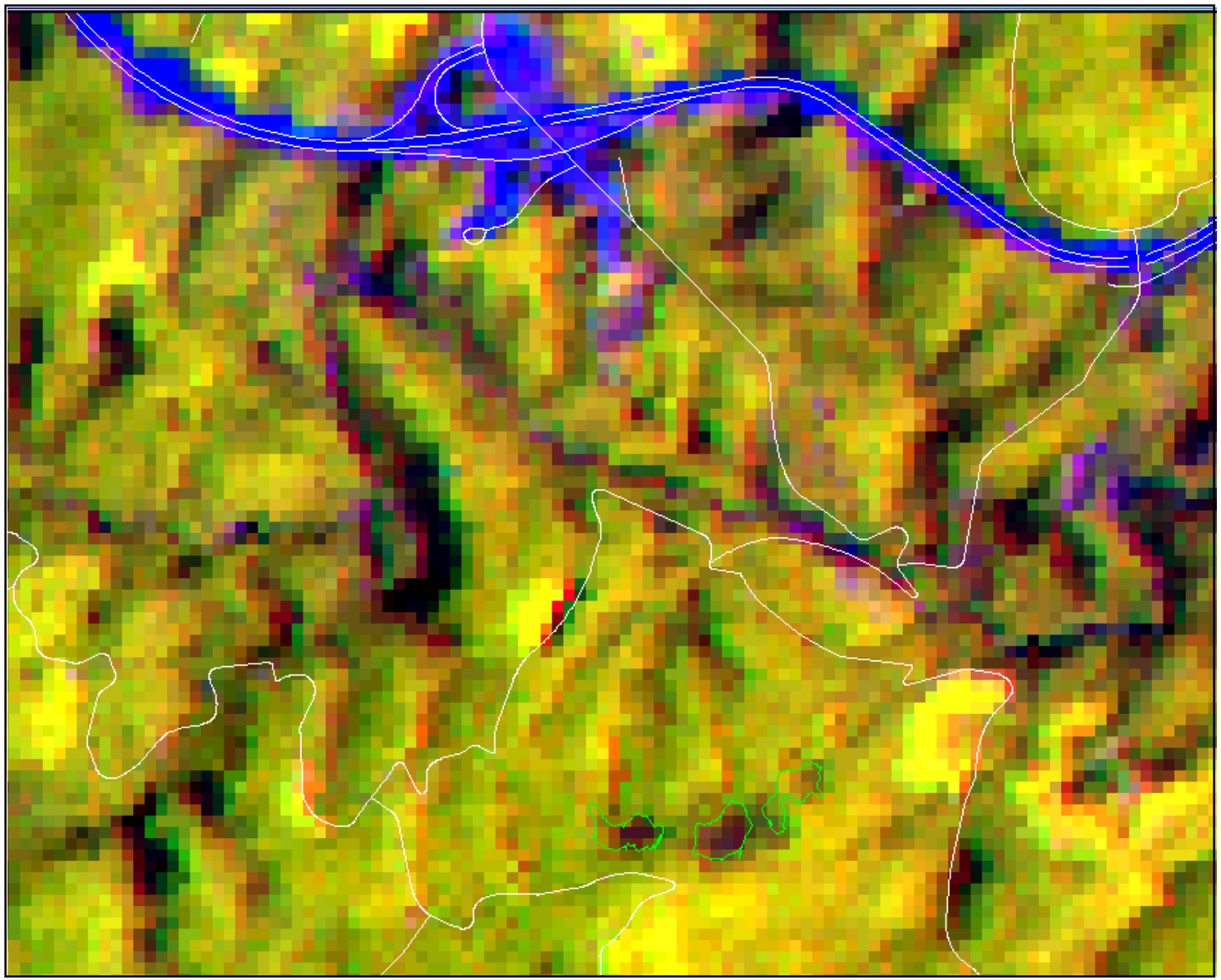
North America

- Just now getting EO-1 data
- AVIRIS underflights (summer)
- 1000s of plots (composition)
- 100s of plots (structure)
- 50 plots (canopy chemistry)

Hyperion 07-24-01 Wavelengths (1104 (R), 763(G), 681(B))
Green Ridge State Park, MD

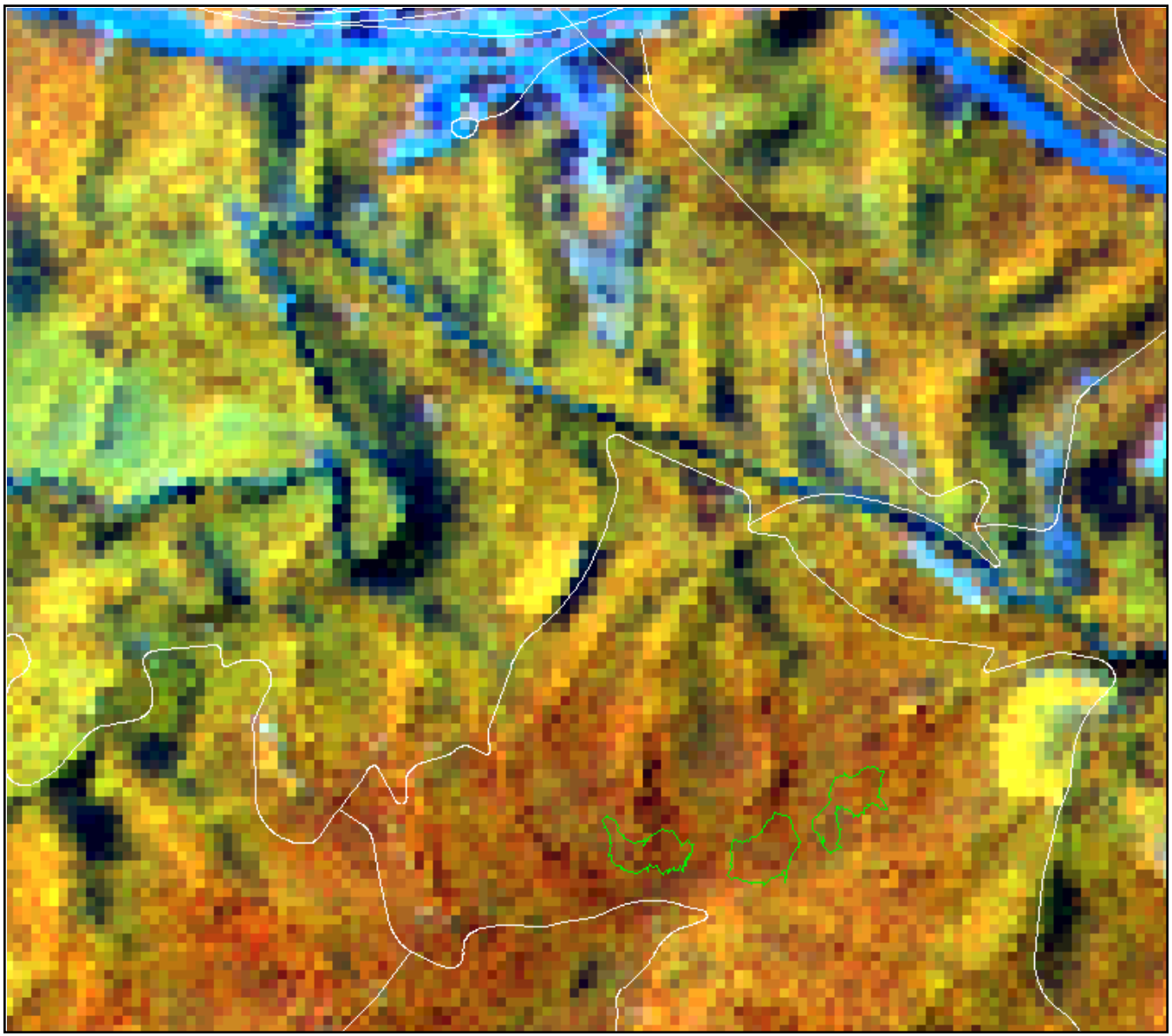


Hyperion Zoom 07-24-01 Wavelengths (1104 (R), 763(G), 681(B))
Green Ridge State Park, MD

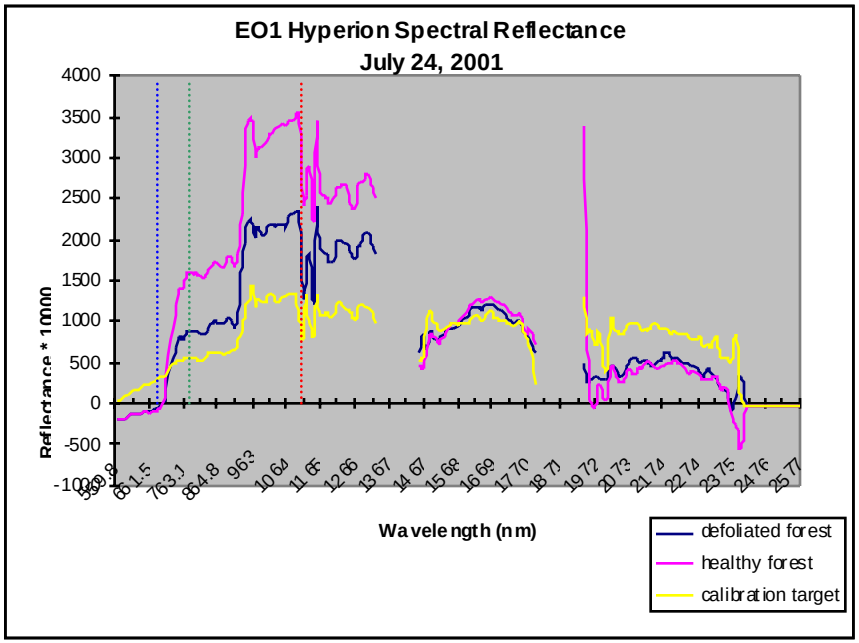


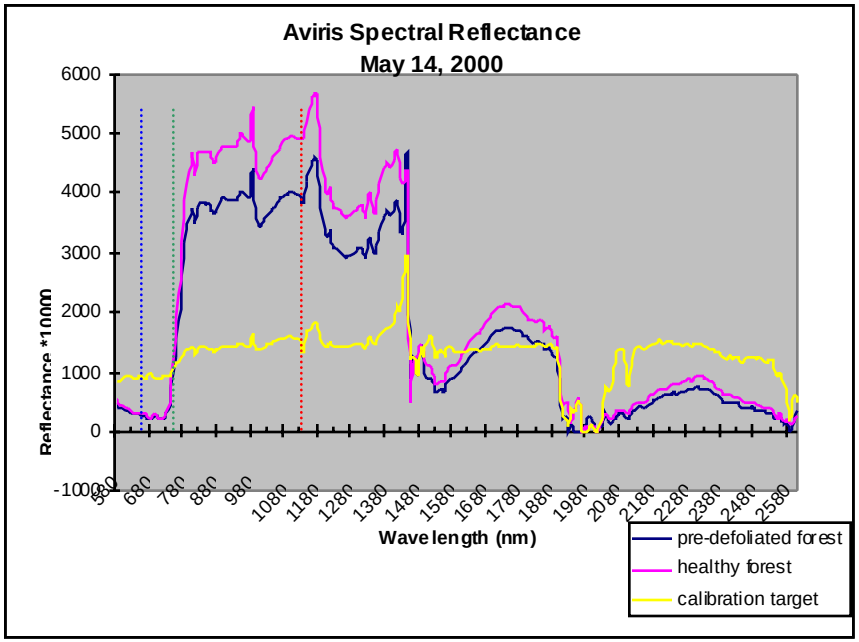
Aviris 05-14-00 Wavelengths (1100 (R), 760(G), 680(B))
Green Ridge State Park, MD

Aviris Zoom 05-14-00 Wavelengths (1100 (R), 760(G), 680(B))
Green Ridge State Park, MD



EO1 Hyperion and Aviris Spectral Reflectance Plots





Information from Steve Ungar
Upcoming EO-1 Activities

October	Second Australian Field Campaign	Coleambally
Nov 6-8	SVT and AVIRIS Campaign Workshop	BA, Argentina
Dec. 1	Termination of Base Mission??	

Funding is in place for continued Science Validation operations through mid-November, 2001 and SVT PI analysis activities through FY 2002.

They are trying to organize an "Extended Mission," about which Garik may have some insights….