Section 18

EO-1 Science Validation Team (SVT)

. . . Stephen G. Ungar
Earth Observing-1 Mission Scientist
Biospheric Sciences Branch, Code 923
NASA Goddard Space Flight Center

Science Validation Team (SVT)

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

- ***NASA Selected Investigators***
  - ***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)***

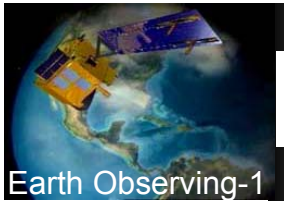
- ***International Collaborators***
  - ***Argentina, Australia, Canada, Italy, Japan, Singapore***

Mission Science Office

- ***Assist and advise Project and NASA HQ management***
- ***Coordinate Science Validation Team activities***
  - ***Instrument Team***
  - ***NASA Selected Investigators***
  - ***International Collaborators***
- ***Provide mission planning/data acquisition activities***
- ***Maintain the Science Validation Facility (SVF)***
  - ***Process Level-1 ALI data***
  - ***Distribute all data in compliance with data policy***
  - ***Generate special products***
  - ***Monitor data quality***
- ***Fill special requests and coordinate with other agencies***
- ***Conduct in-house complimentary validation activities***

SVT Activities - First 120 Days

- ***Day 1 – 90 (Instrument Team)***
  - ***Validate/re-establish and refine pre-launch characterizations***
  - ***Provide technology validation***
  - ***Participate on SVT***
- ***Day 61 - 120 (NASA Selected Investigators)***
  - ***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)***
- ***Day 31 - 120 (International Collaborators)***
  - ***Argentina, Australia, Canada, Italy, Japan, Singapore***

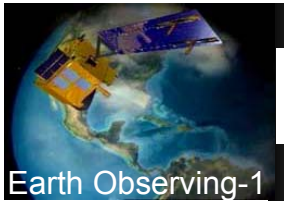


Investigator Research Topics *(1 of 3)*

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 *(2 of 3)*

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

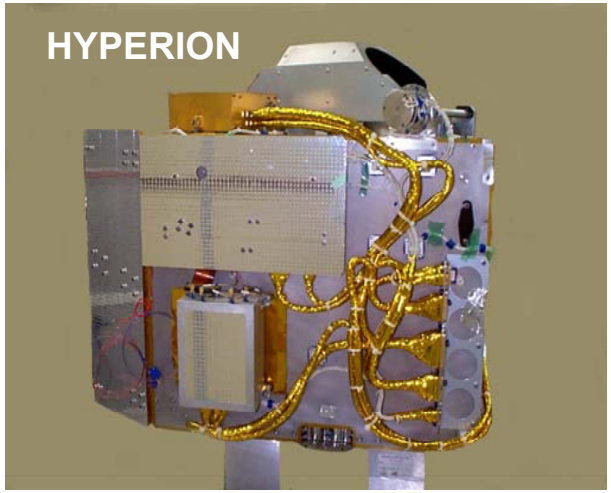


Investigator Research Topics *(3 of 3)*

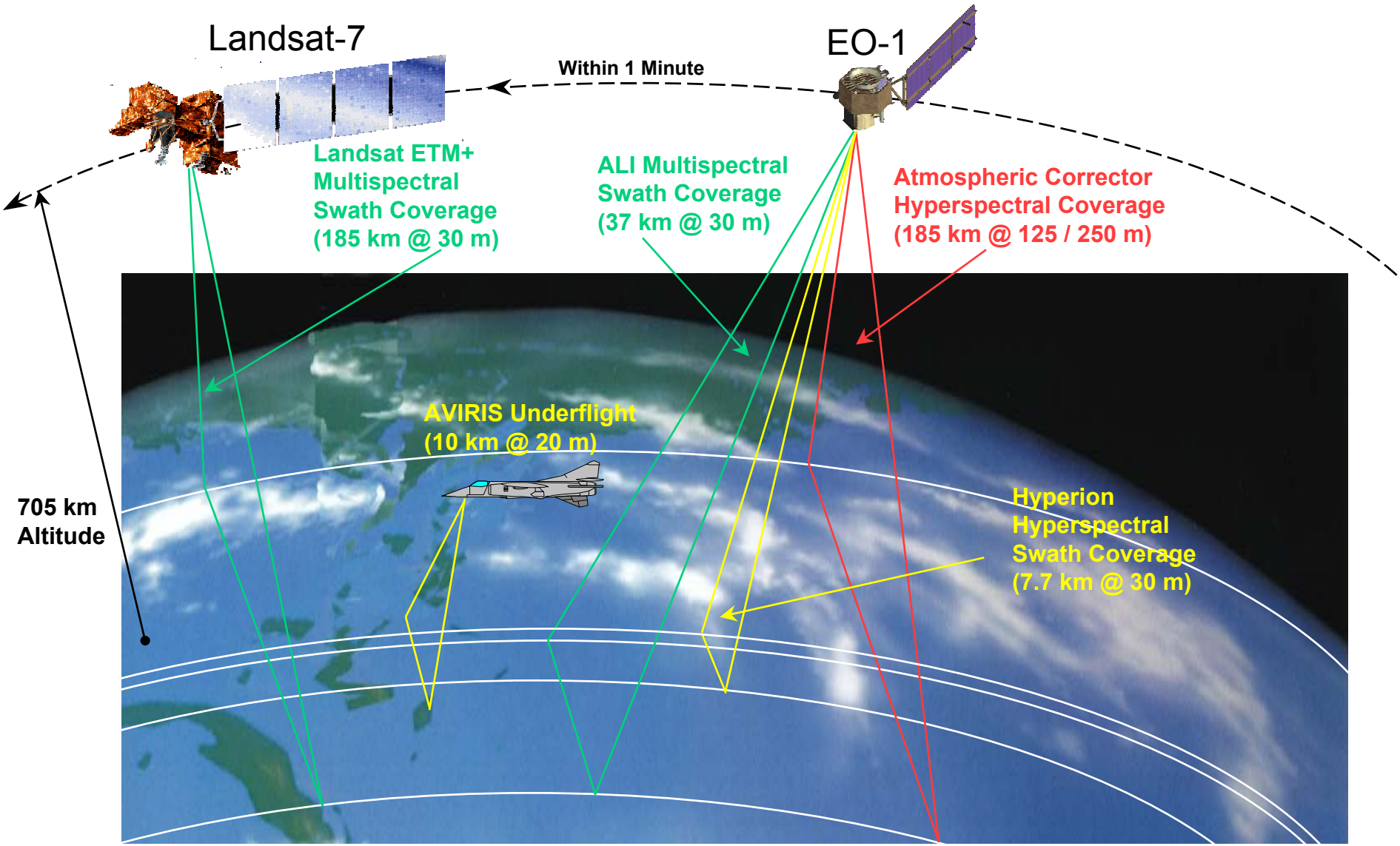
Research Topic	Principal Investigator
Ecological Applications in Yellowstone National Park	**Boardman, J. W., AIG,** Colorado
Commercial Applications	**Cassady, P. E.,** Boeing, Washington
Radiometric and Spatial Evaluation of ALI and Hyperion	**Biggar, S. F.,** University of Arizona
Atmospheric Correction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

Role of EO-1 SVT

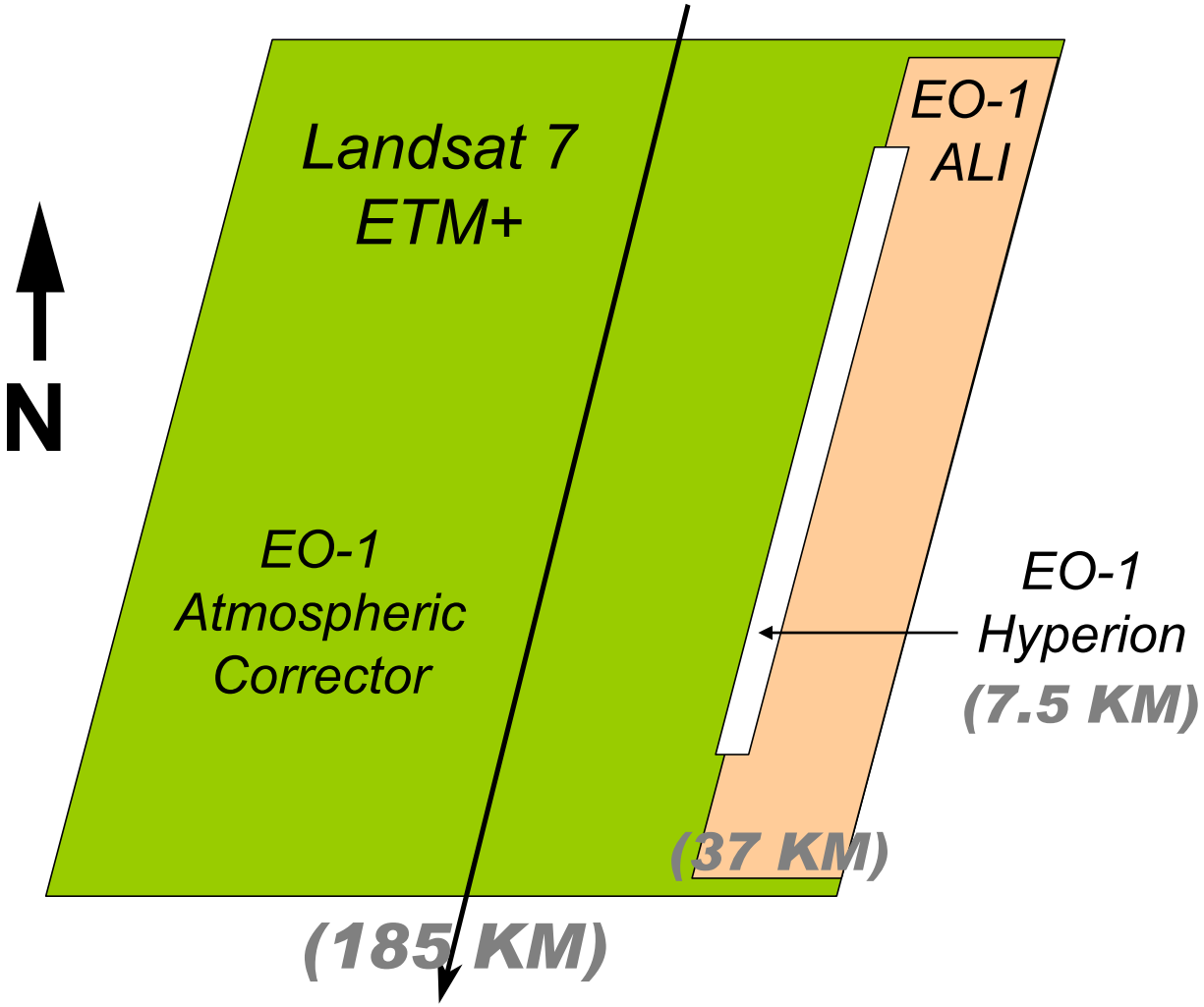
Science Validation Team Evaluates Performance of EO-1 Flight Instruments

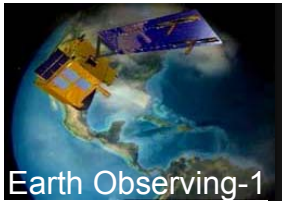


EO-1 & Landsat


Landsat-7
EO-1
Within 1 Minute
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)
AVIRIS Underflight
(10 km @ 20 m)
705 km
Altitude
Hyperion
Hyperspectral
Swath Coverage
(7.7 km @ 30 m)

EO-1 & Landsat-7 Descending Orbit Ground Tracks





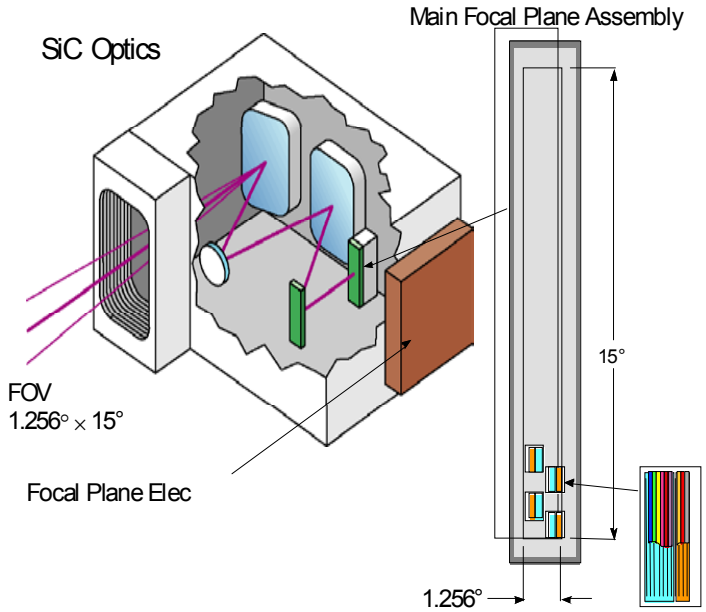
EO-1 Instrument Overviews

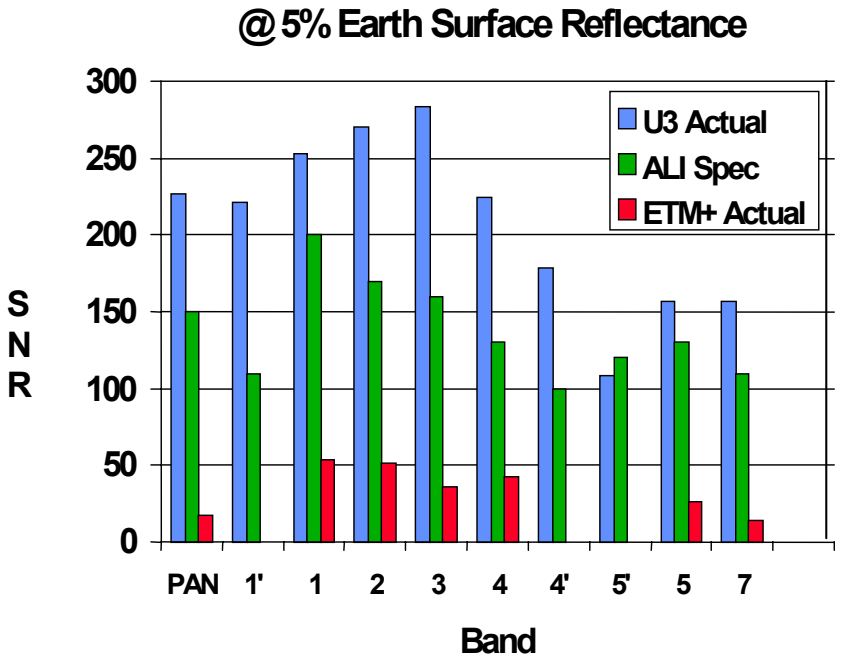
Parameters	Landsat-7 ETM+	EO-1 ALI Multispectral	EO-1 Hyperion	EO-1 AC
Spectral Range	04 – 2.4μm *	04 – 2.4μm	04 – 2.5μm	0.9 – 1.6μm
Spatial Resolution	30m	30m	30m	250m
Swath Width	185Km	37Km	7.7Km	185Km
Spectral Resolution	Variable	Variable	10nm	2.3 – 9nm **
Spectral Coverage	Discrete	Discrete	Continuous	Continuous
Pan Band Resolution	15m	10m	N/A	N/A
Total Number of Bands	7	10	220	256

* Excludes thermal channel

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

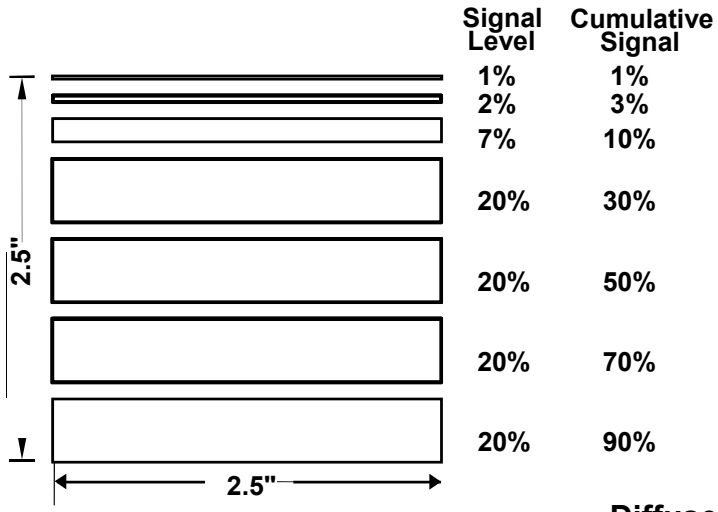
Advanced Land Imager Description

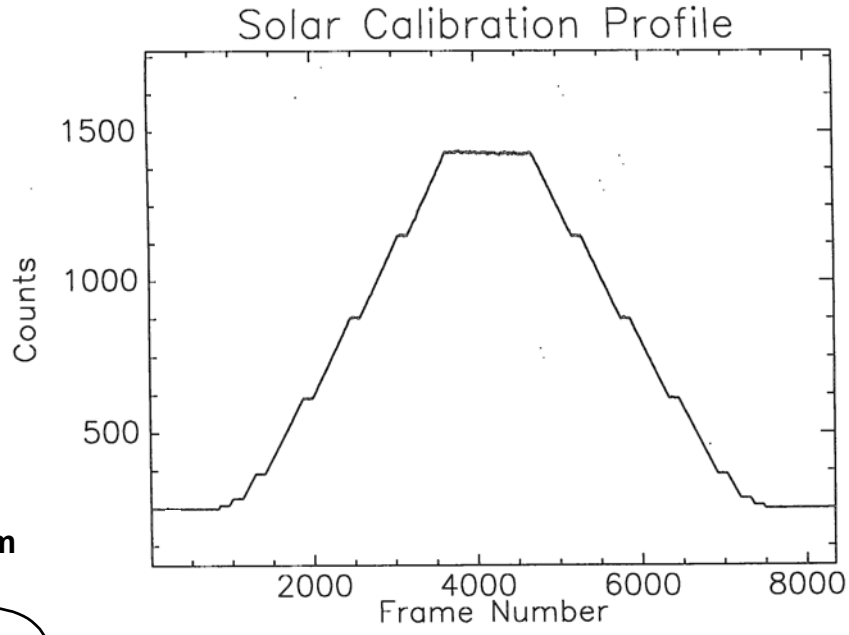


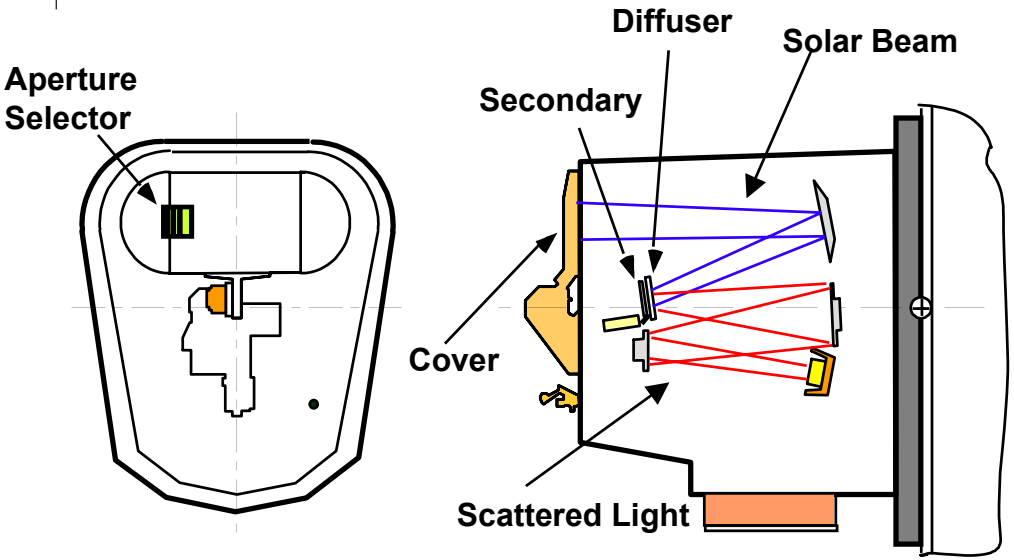


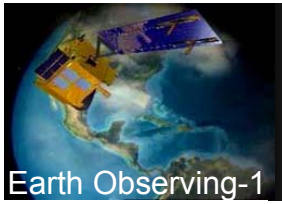
Band	Wavelength (nm)	Band	Wavelength (nm)
Pan	480-690	MS-4	775-805
MS-1’	433-453	MS-4’	845-890
MS-1	450-515	MS-5’	1200-1300
MS-2	525-605	MS-5	1550-1750
MS-3	630-690	MS-7	2080-2350

Solar Calibration









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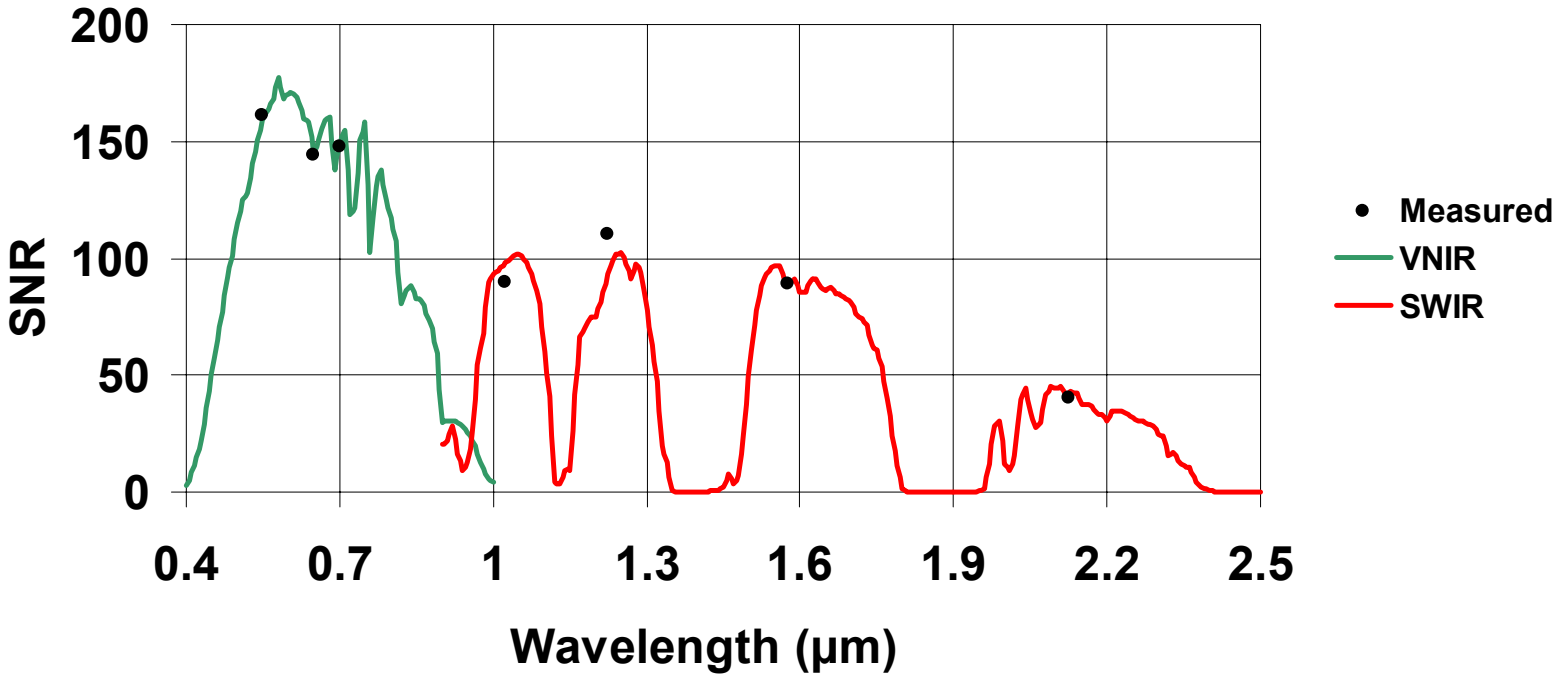
** 35/55 cm^{-1} constant resolution

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° Solar zenith angle and 30% surface reflectance standard mid-latitude summer scene***

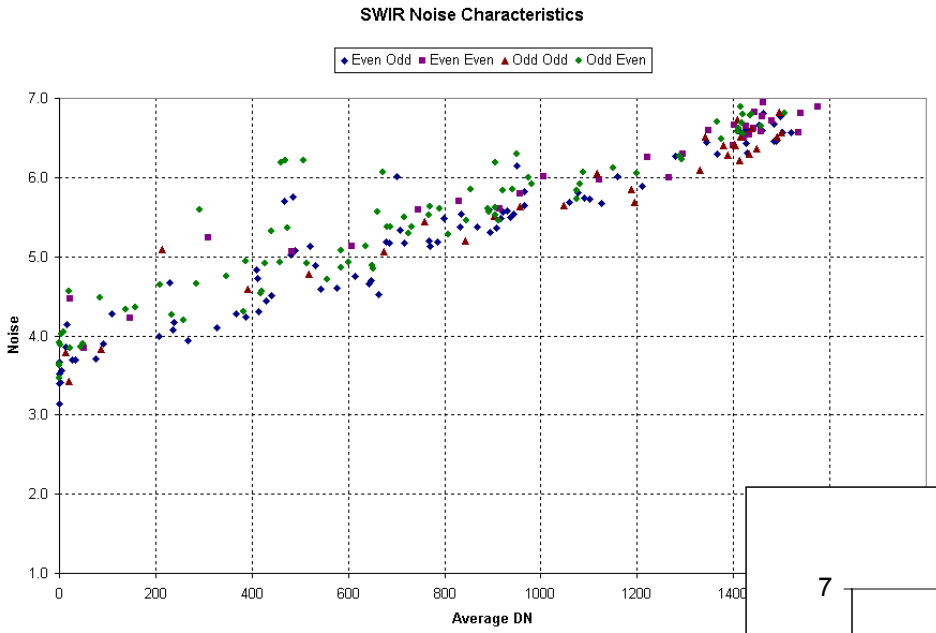


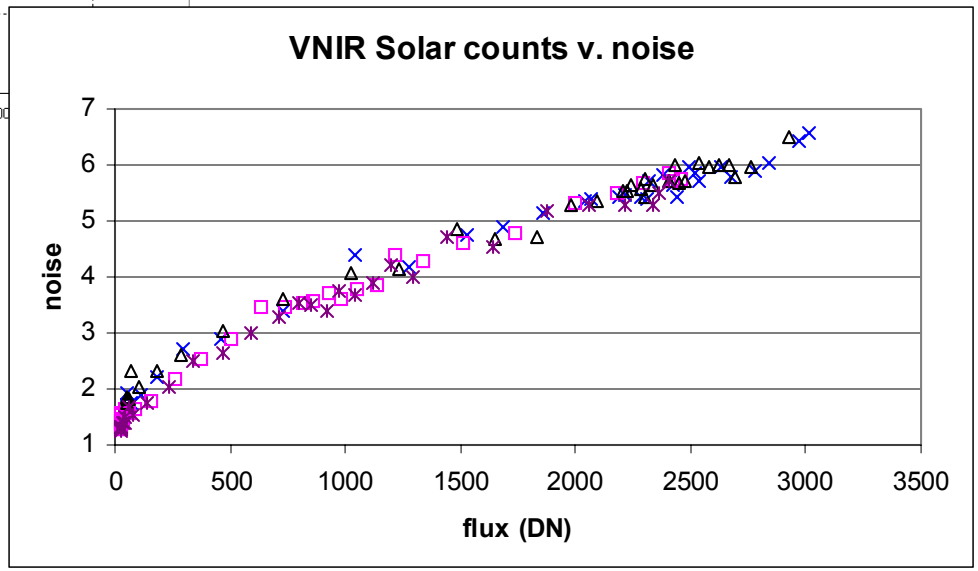
Hyperion Measured SNR						
550 nm	650 nm	700 nm	1025 nm	1225 nm	1575 nm	2125 nm
161	144	147	90	110	89	40

Signal-to-Noise Ratio

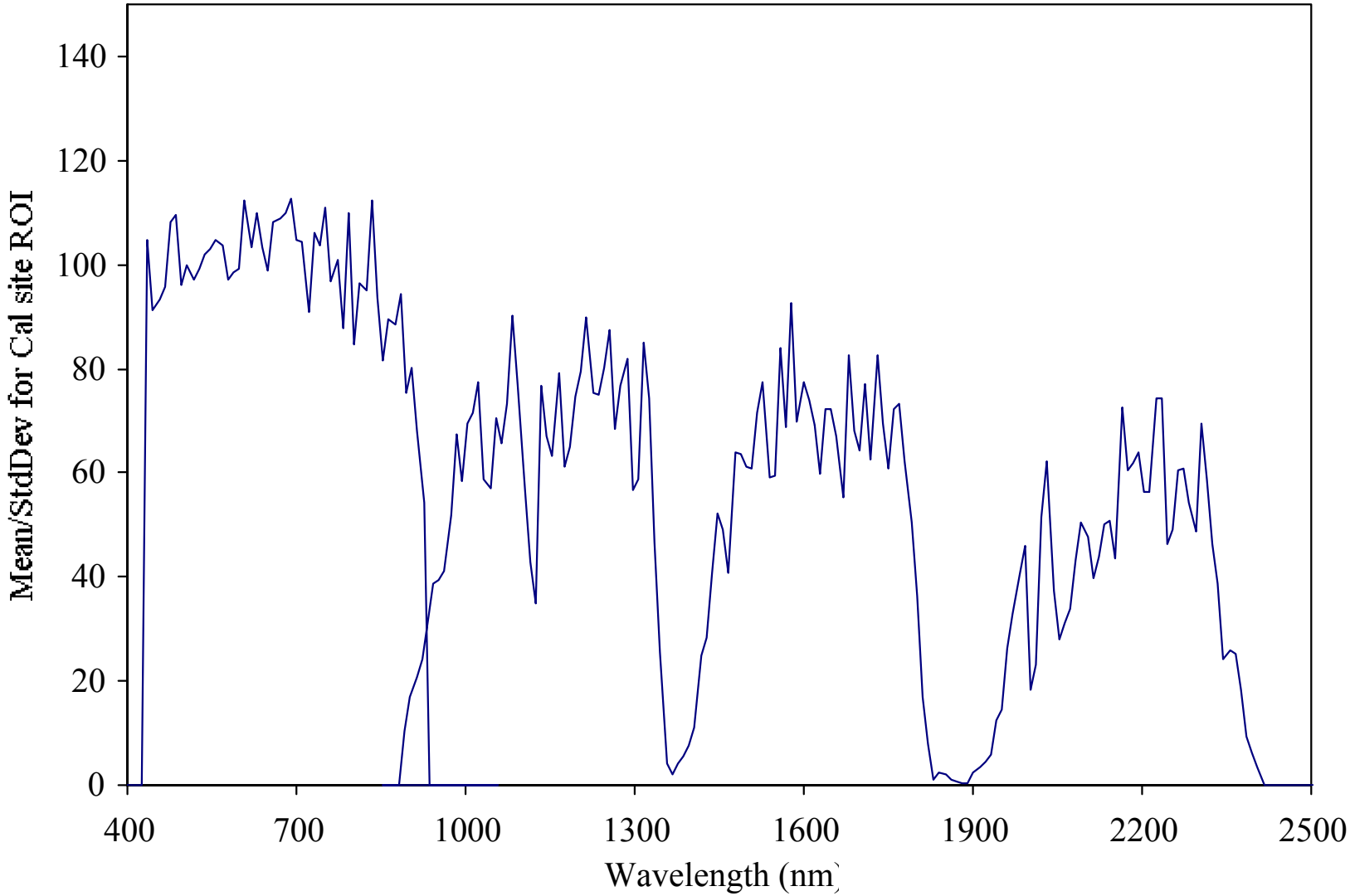
Wavelength (nm)	SNR Requirement	On-Orbit Performance
550	>60	192
650	>60	140
700	>60	140
1025	>60	65
1225	>60	96
1575	>60	64
2125	>30	38

SNR Calculated From Solar Calibration Data





Scene Based Estimate of Hyperion SNR

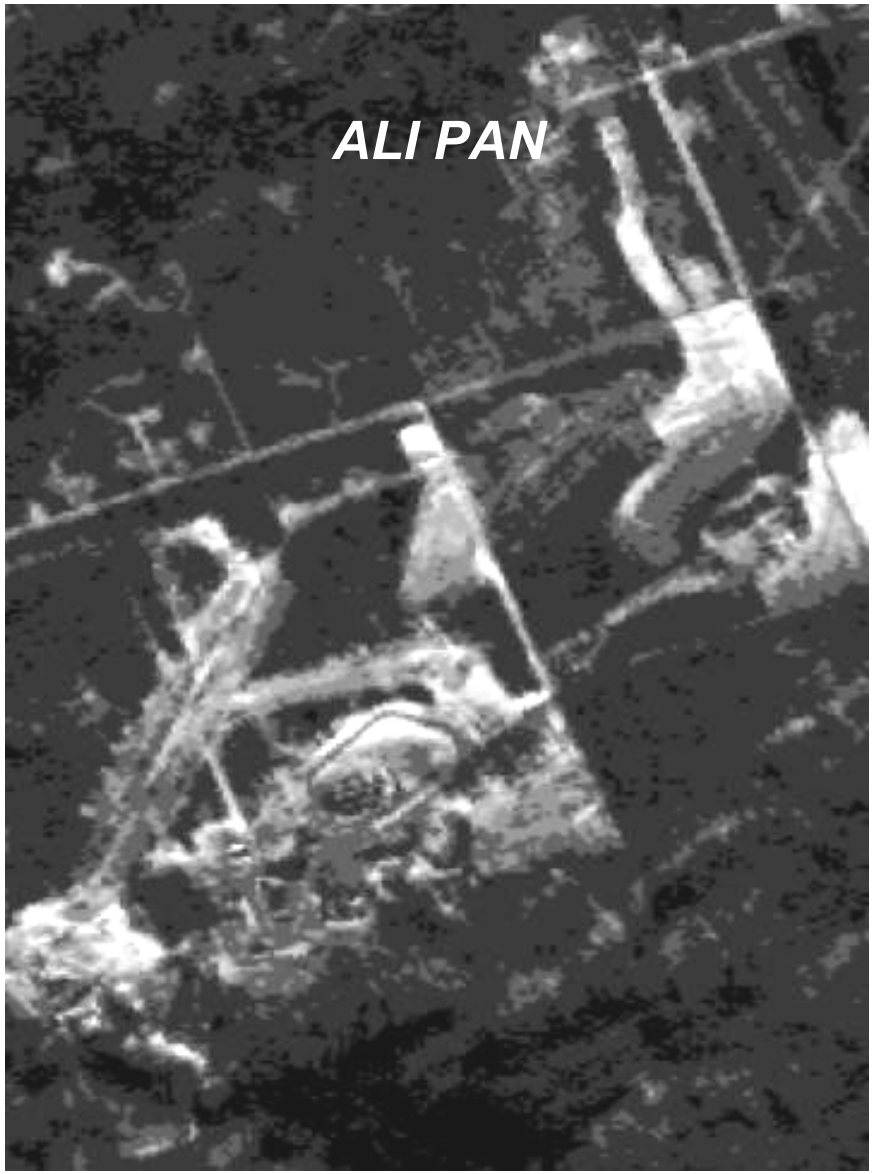


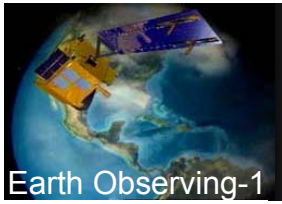
EO-1 Scene Tracking Statistics

Total Scheduled Scenes	***1537***
Scenes Successfully Downlinked	***1452***
Level-0 Data Processed	***1395***
Total Scenes Shipped to PIs	***885***

As of COB 8/08/01

"First Light" Image of Alaska

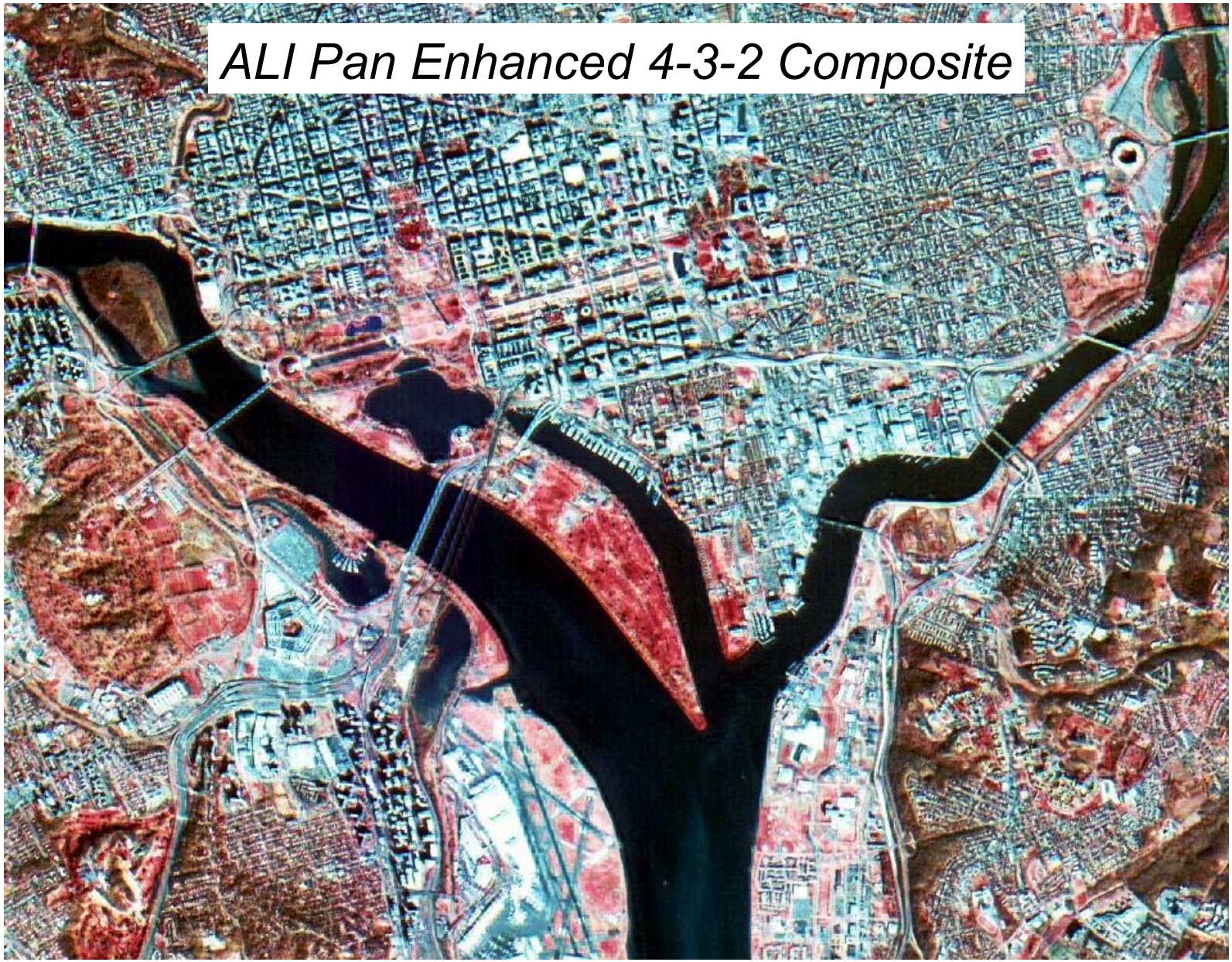




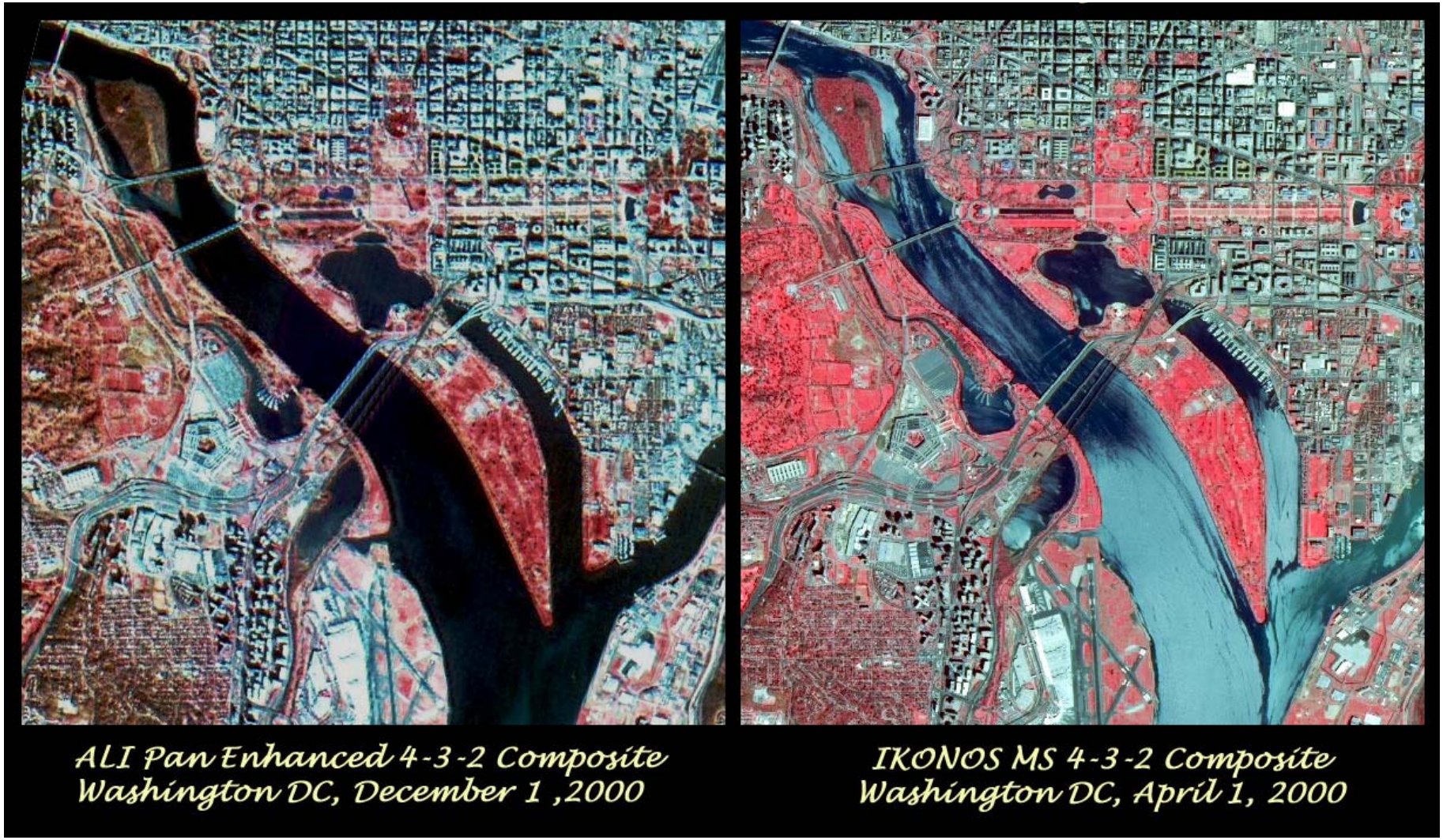
Why is the ALI Pan Band Better Than the ETM+ Pan Band?

- ***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)***

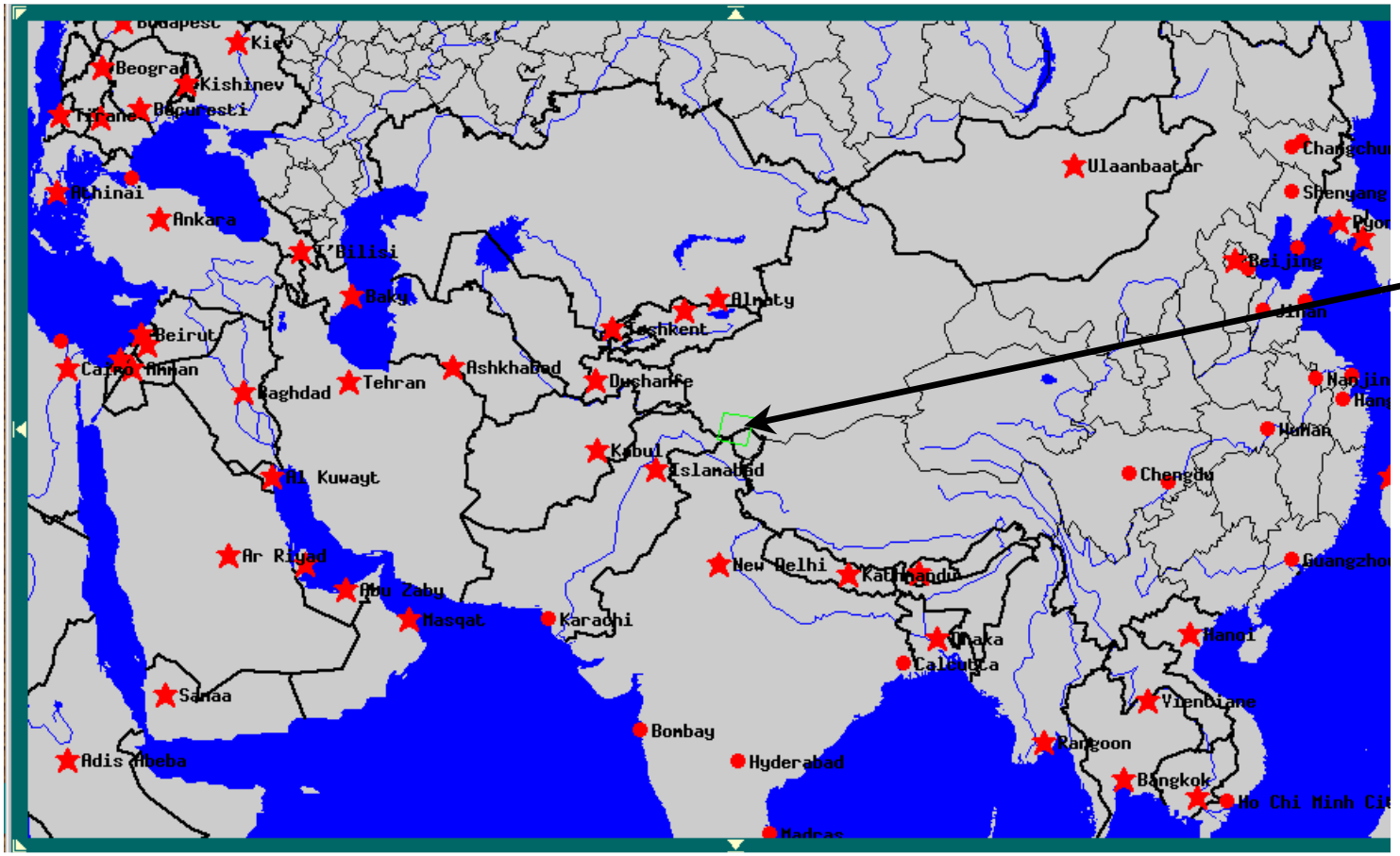
Washington, DC – 12/1/01



EO-1 / ALI & IKONOS Comparison



Area of First Hyperion Image Collection (Green Square)



Area of First Image

Hyperion Image - Argentina

Hyperspectral DCE Acquired Dec 1, 2000
Color image produced using 3 bands in visible
Blue = band 14 (488 nm)
Green = band 20 (549 nm)
Red = band 38 (731 nm) (red shows areas of new spring growth)

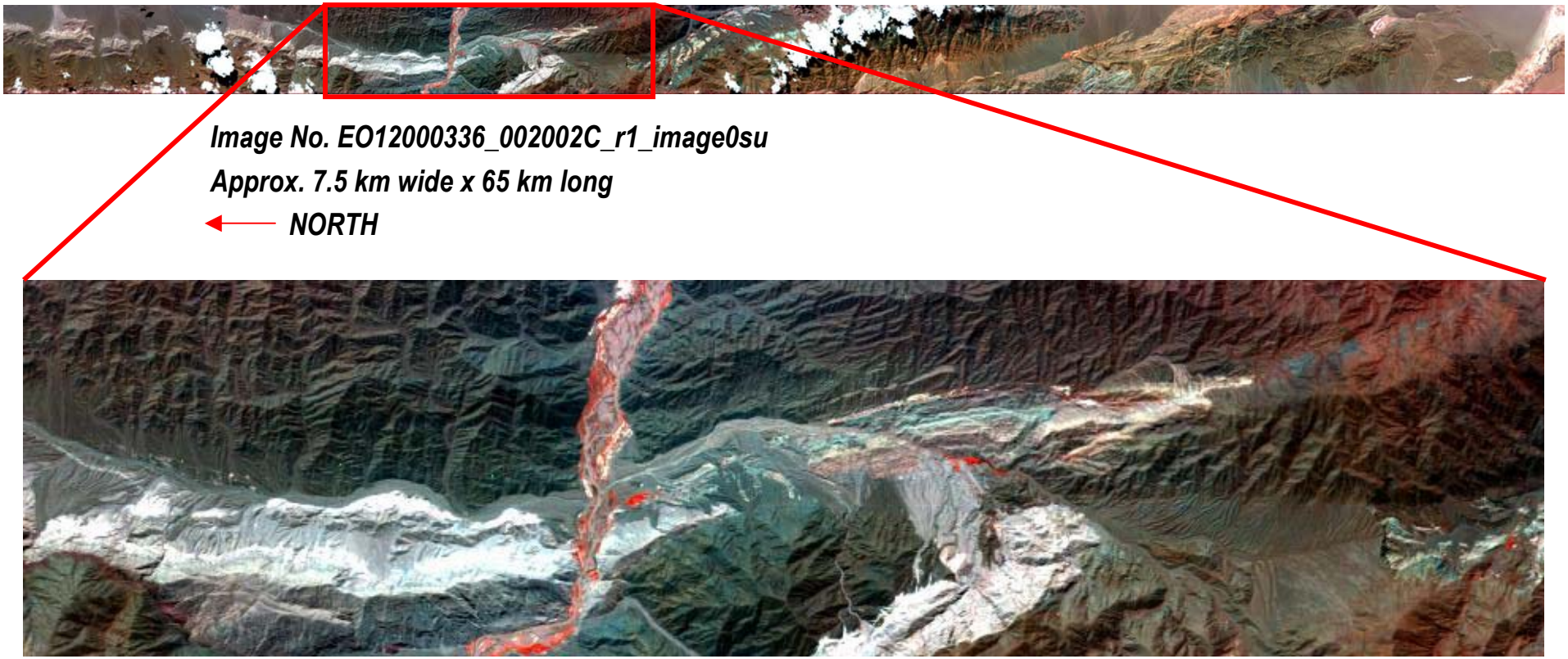
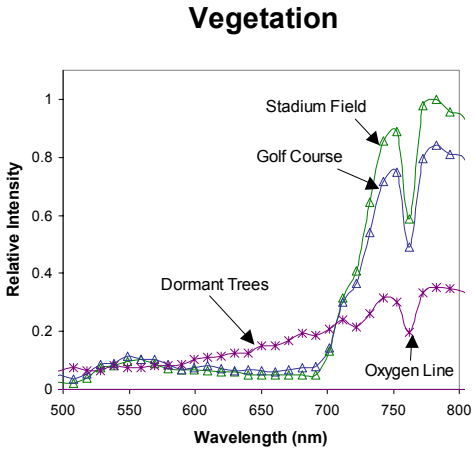


Image No. EO12000336_002002C_r1_image0su
Approx. 7.5 km wide x 65 km long
NORTH

Hyperion Image

Image taken near Washington DC (Fairfax, VA) on Friday December 1, 2000

This image, taken by the Hyperion Imaging Spectrometer on EO-1, reveals the relative chlorophyll content of vegetation in an area of Fairfax County, Va. The spectral profiles indicate healthy grass in the stadium field and golf course. The spectral profile of the trees indicates dormant vegetation.



Oxygen in the atmosphere is detected at near infrared wavelengths in the spectral profiles.

Courtesy of TRW Inc.

Sample Hyperion Images

Blythe
Day 007

San Francisco
Salt Ponds
Day 017

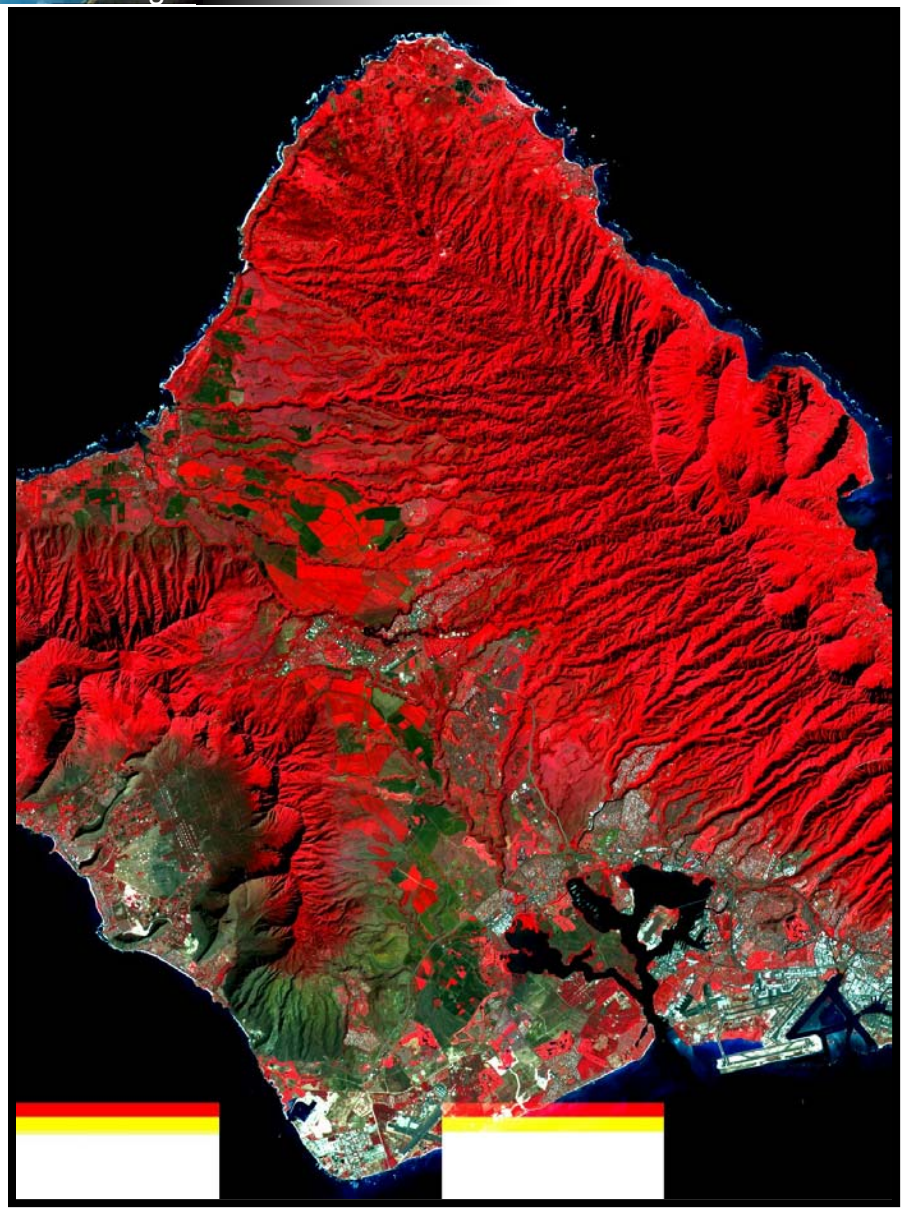
LAC Image (1.26µm)

Tumbarumba, Australia (Lake Hume in center)

December 25, 2000

February 12, 2001

Oahu - December 19, 2000



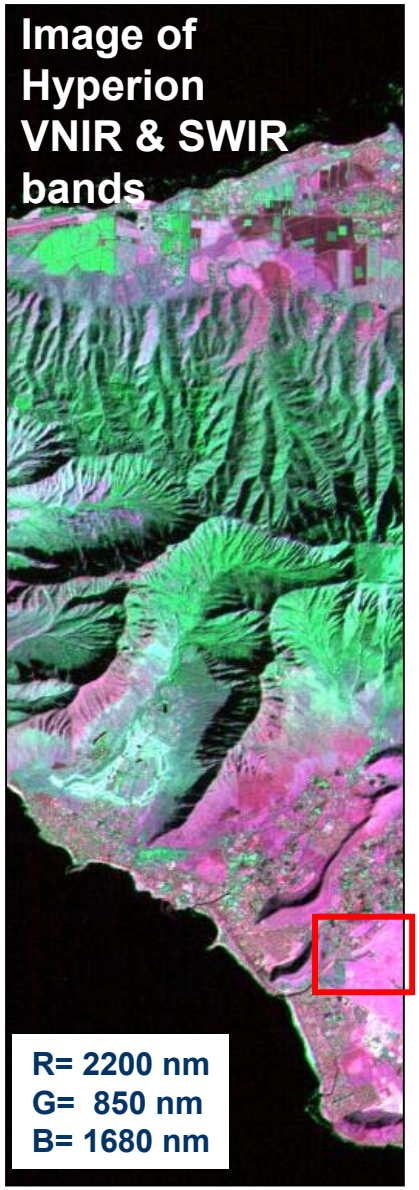
Advanced Land Imager
Color Composite

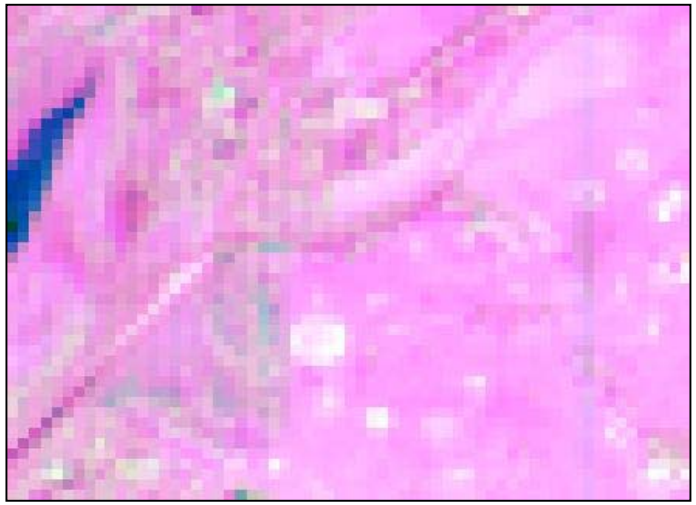
R = Band 4

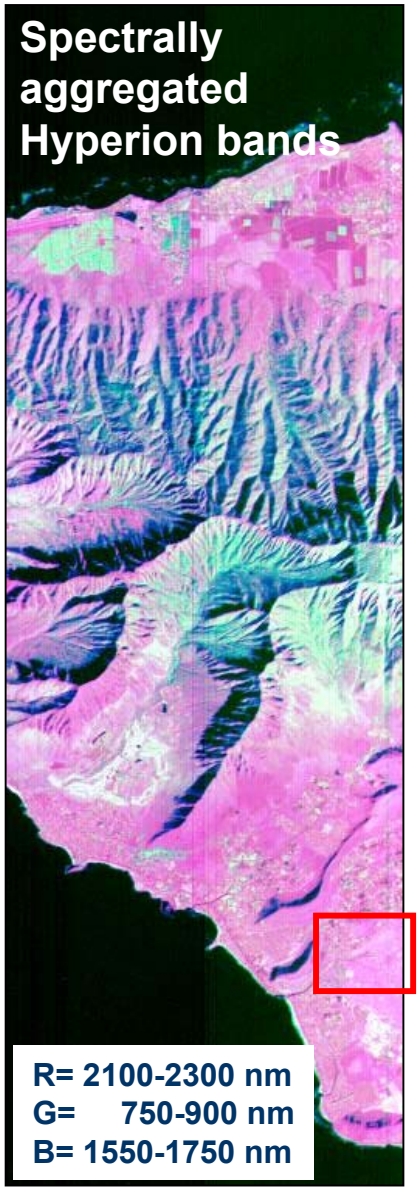
G = Band 3

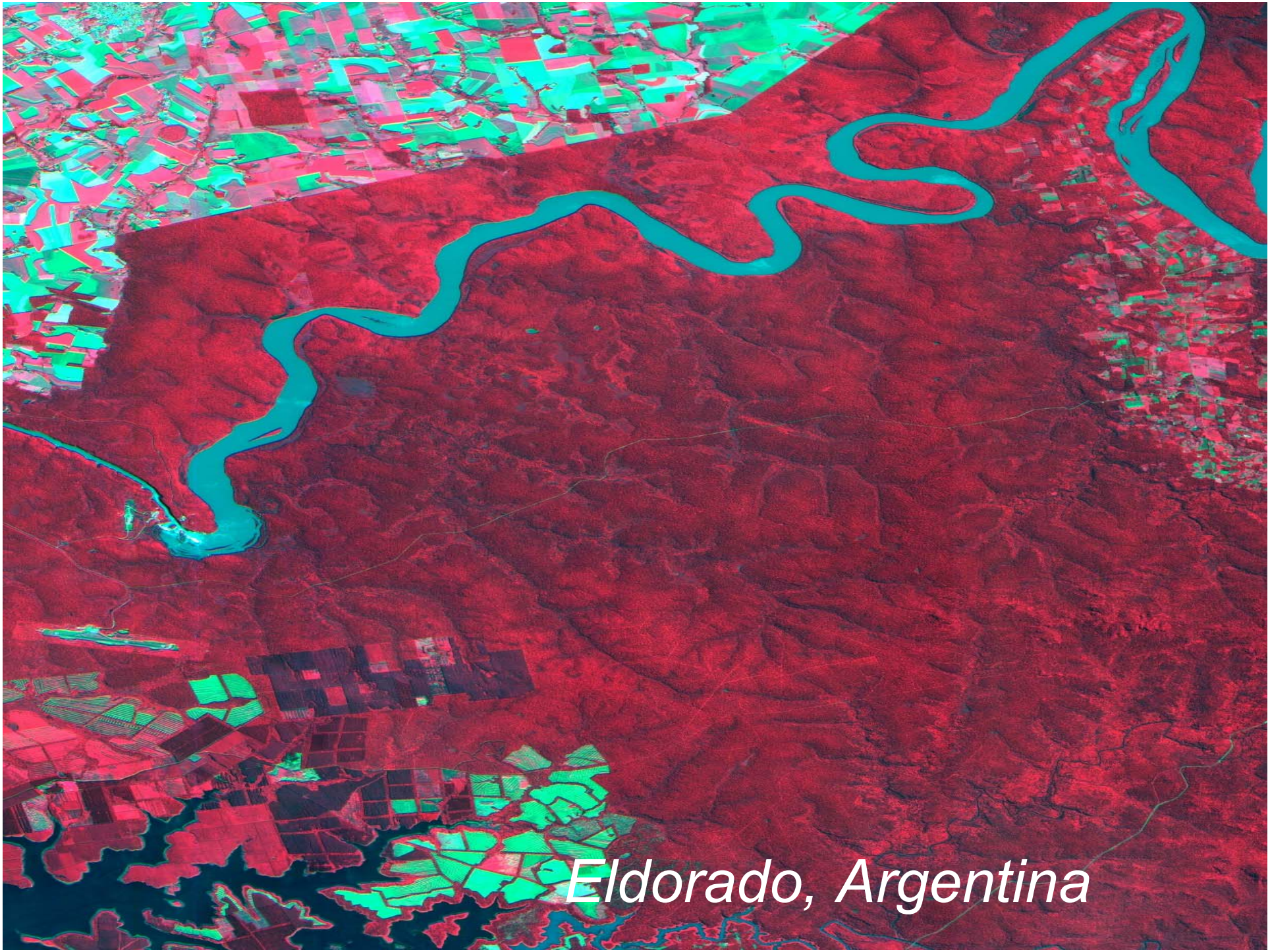
B = Band 2

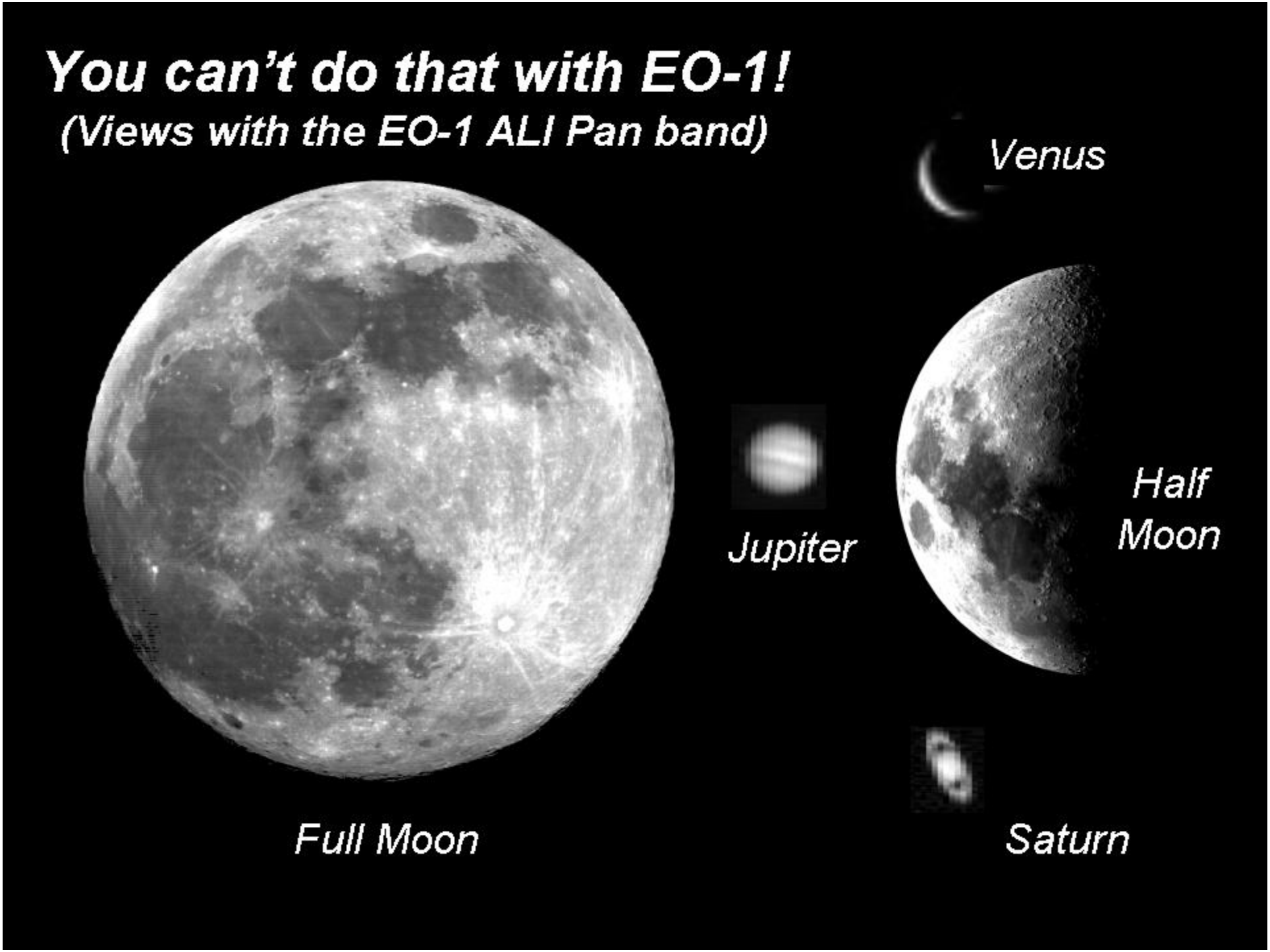
Oahu - December 19, 2000








Eldorado, Argentina


You can't do that with EO-1!
(Views with the EO-1 ALI Pan band)
Venus
Half Moon
Jupiter
Full Moon
Saturn

Out of this World Calibration

Hyperion image of the moon

Lunar image provides direct-viewing radiometric measurements for calibration without atmospheric effects.

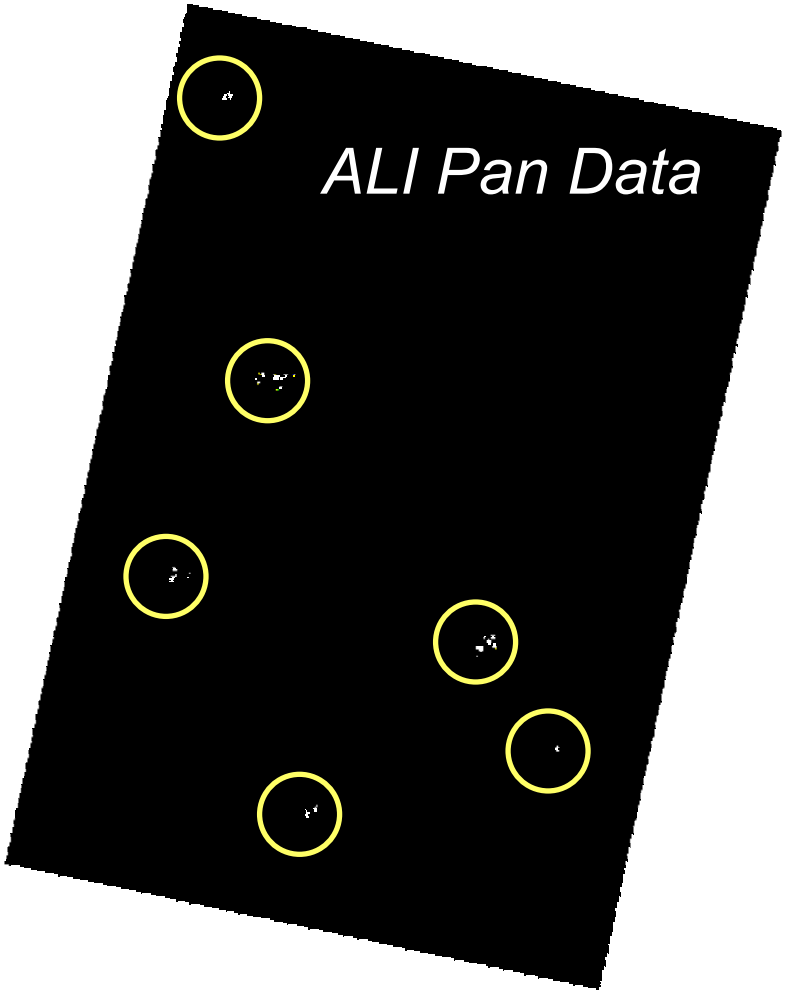
Issues of the lunar model and analysis techniques are being addressed

Courtesy of P. Barry & H. Kieffer

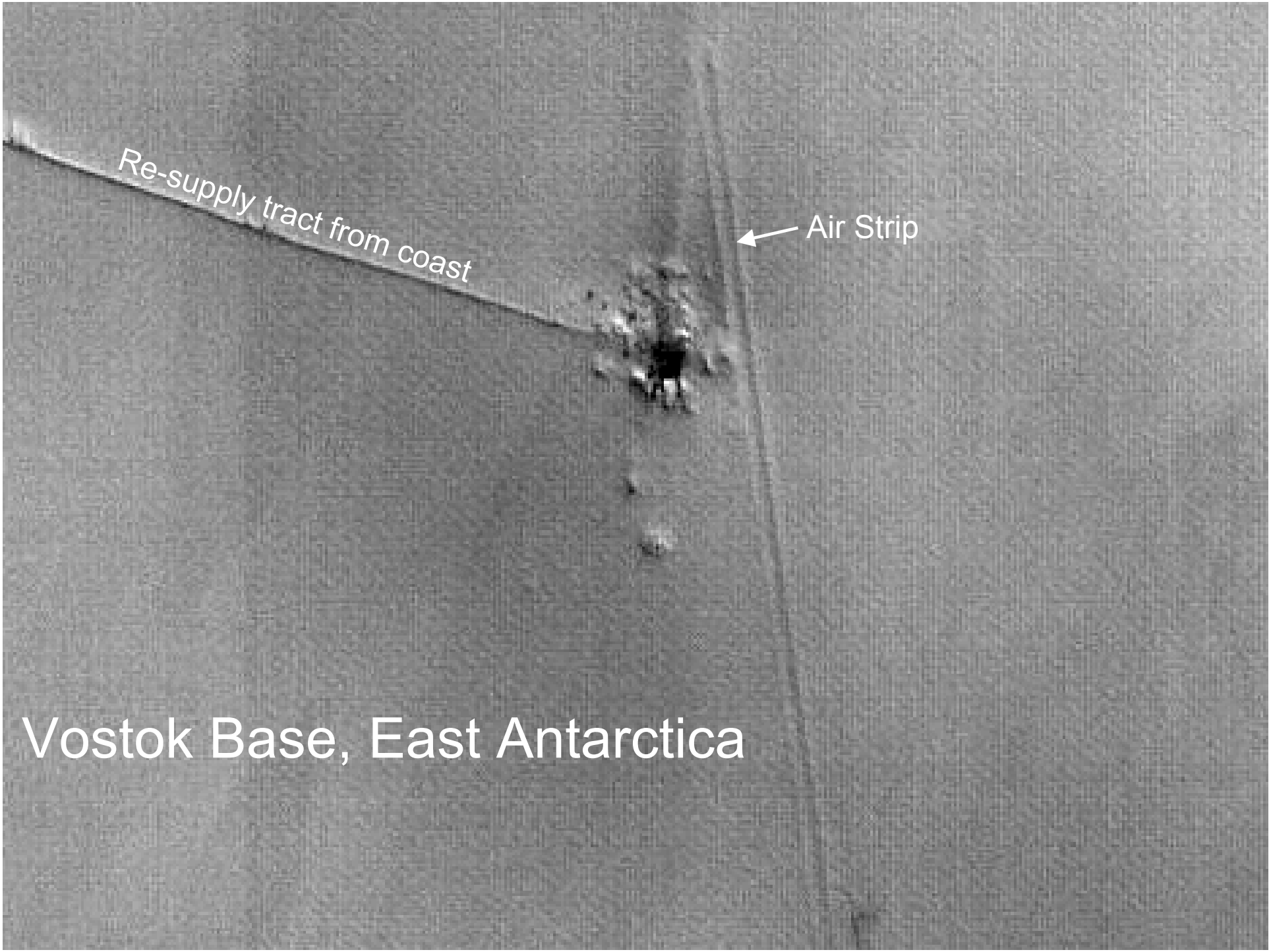
You Can't Do That With EO-1!

(Views with the EO-1 ALI Pan band)

The Pleiades



ALI detections

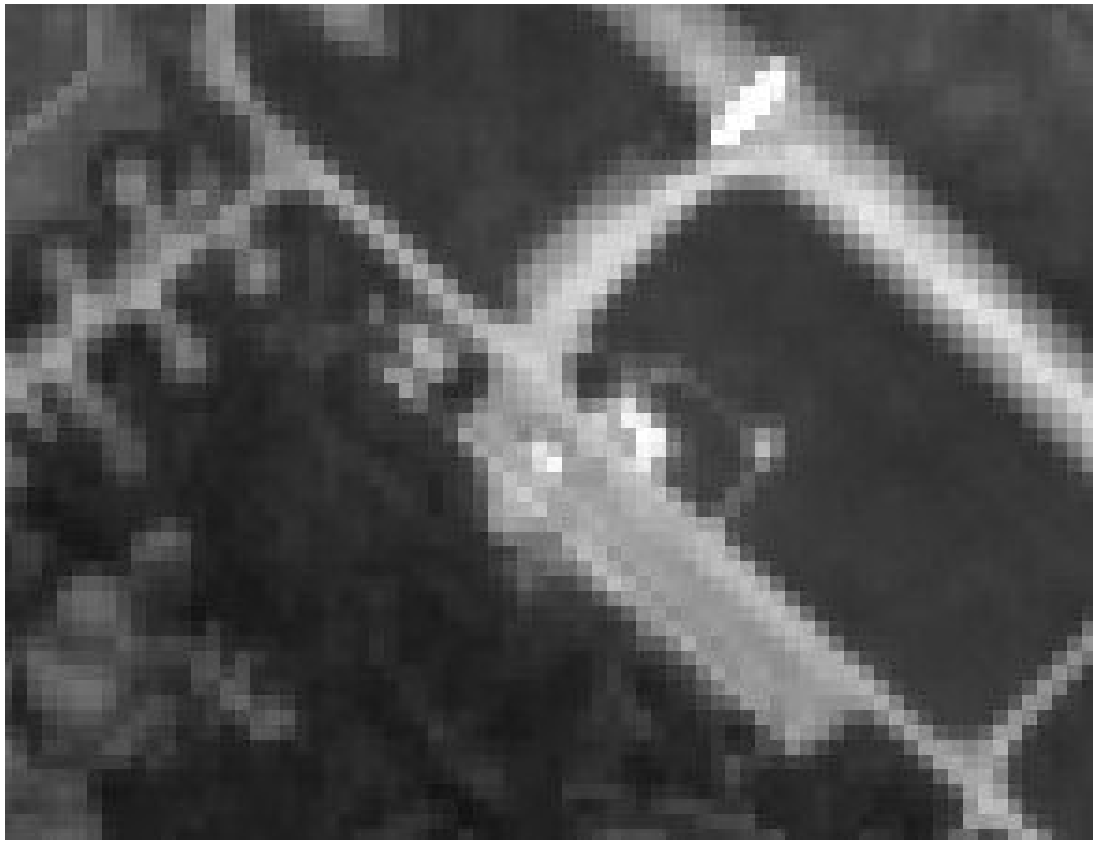


Vostok Base, East Antarctica

Lingshui Airfield 4/10/01

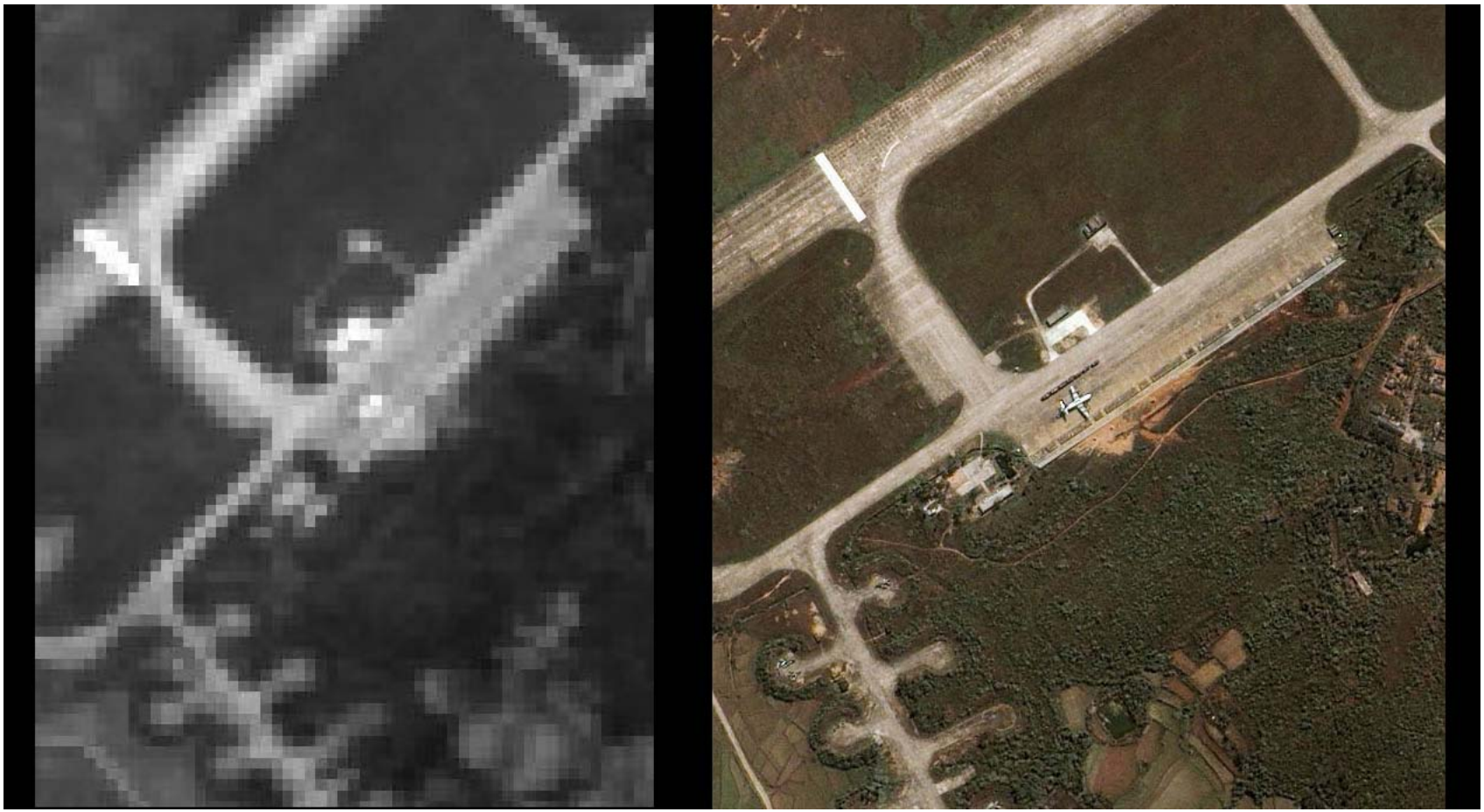
ALI Pan Band

Lingshui Airfield 4/10/01



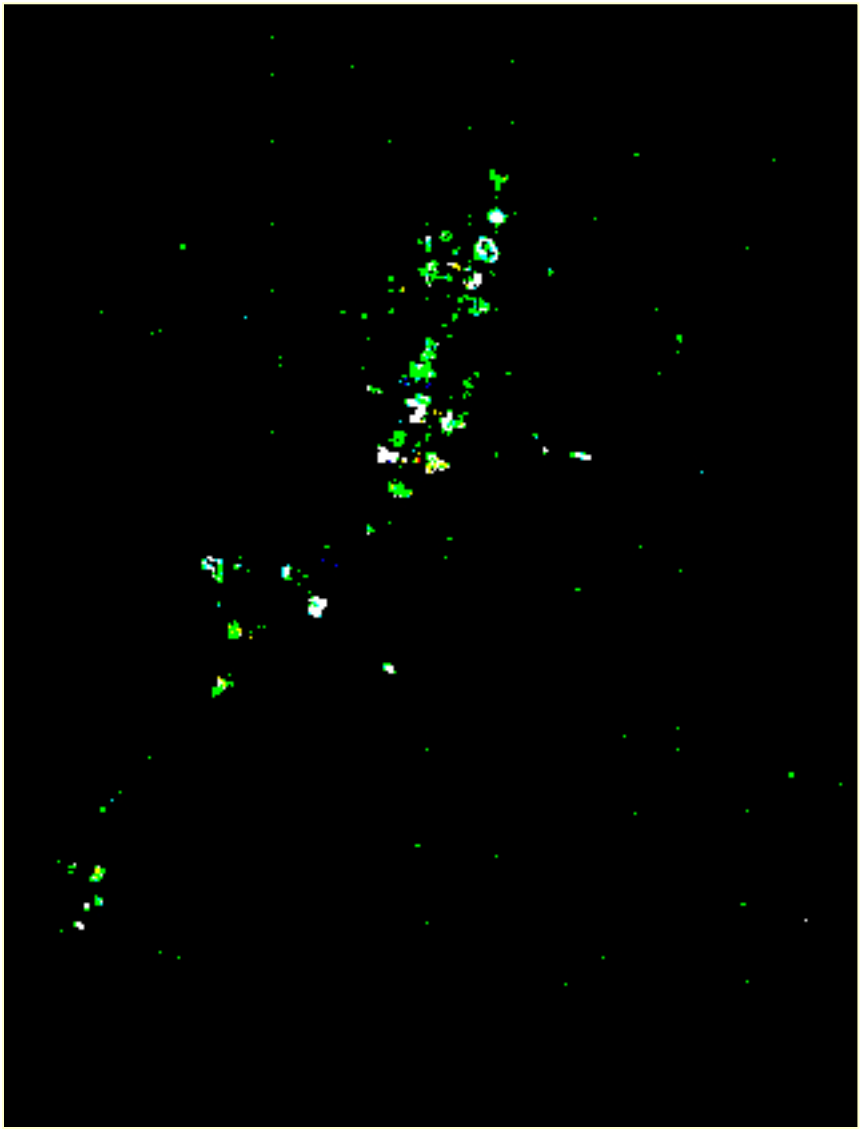
ALI Pan Band

Lingshui Airfield 4/10/01



ALI Pan Band

I can't tell you!



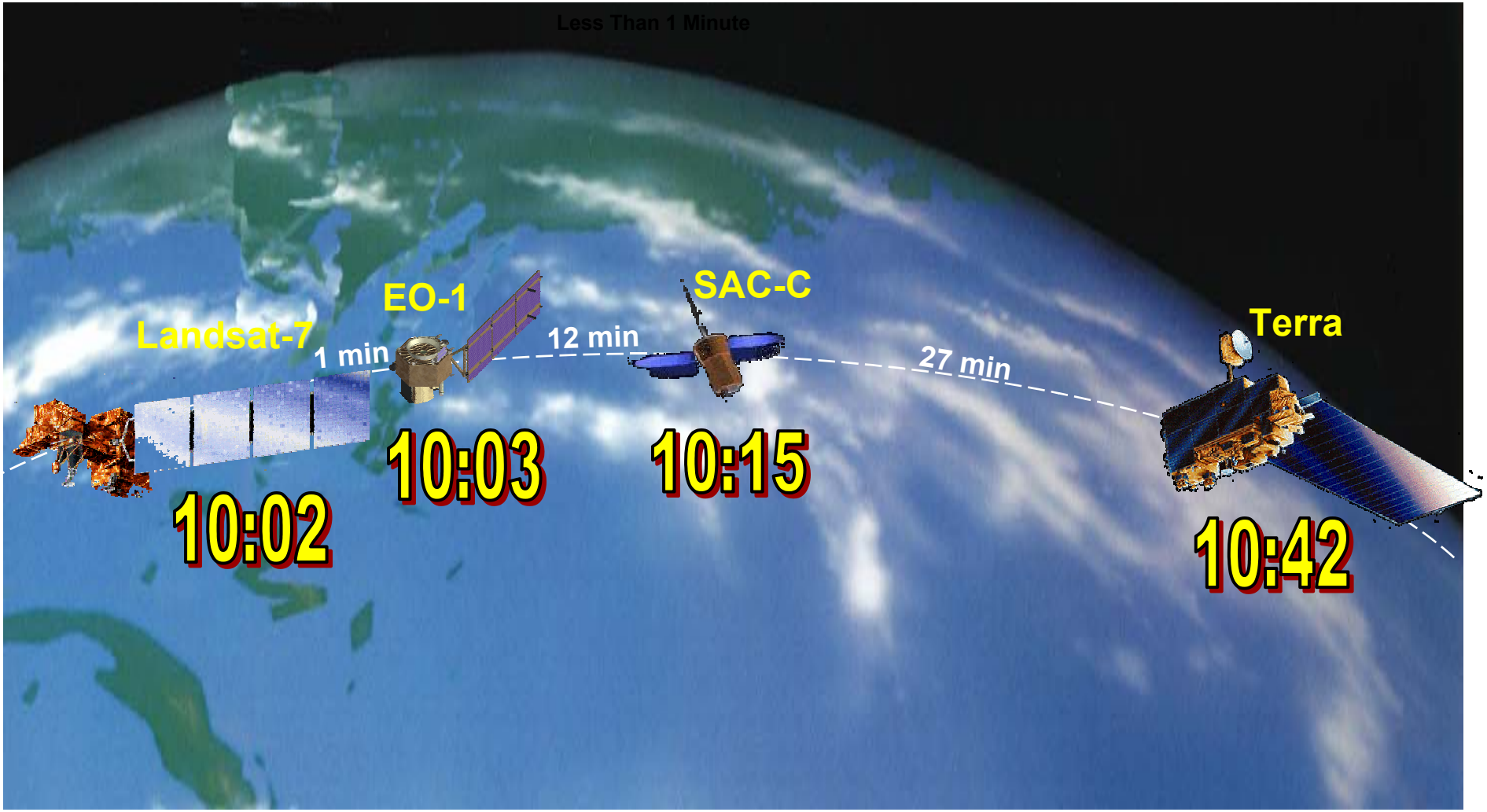
“The Strip”

Las Vegas

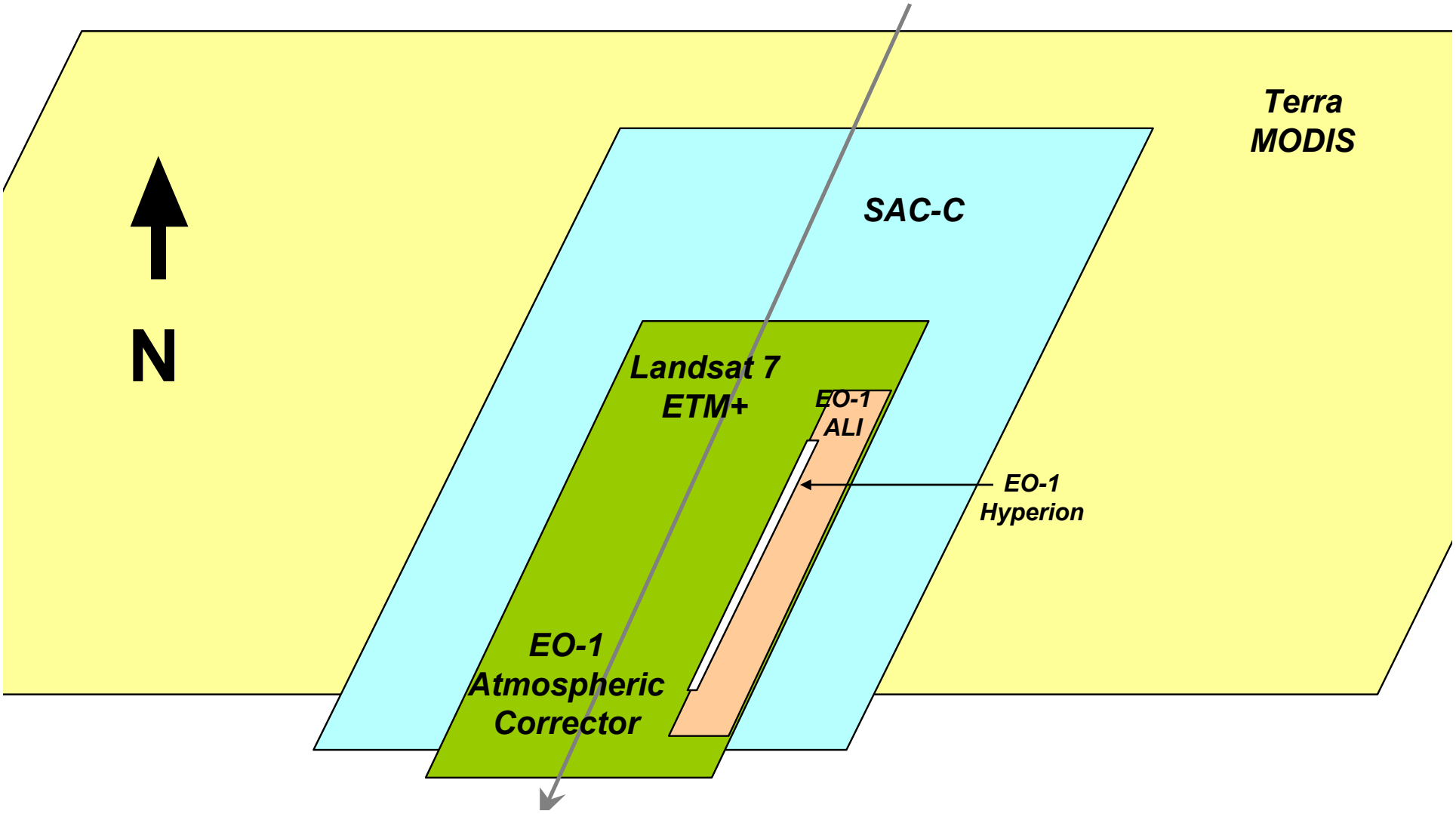
Nevada

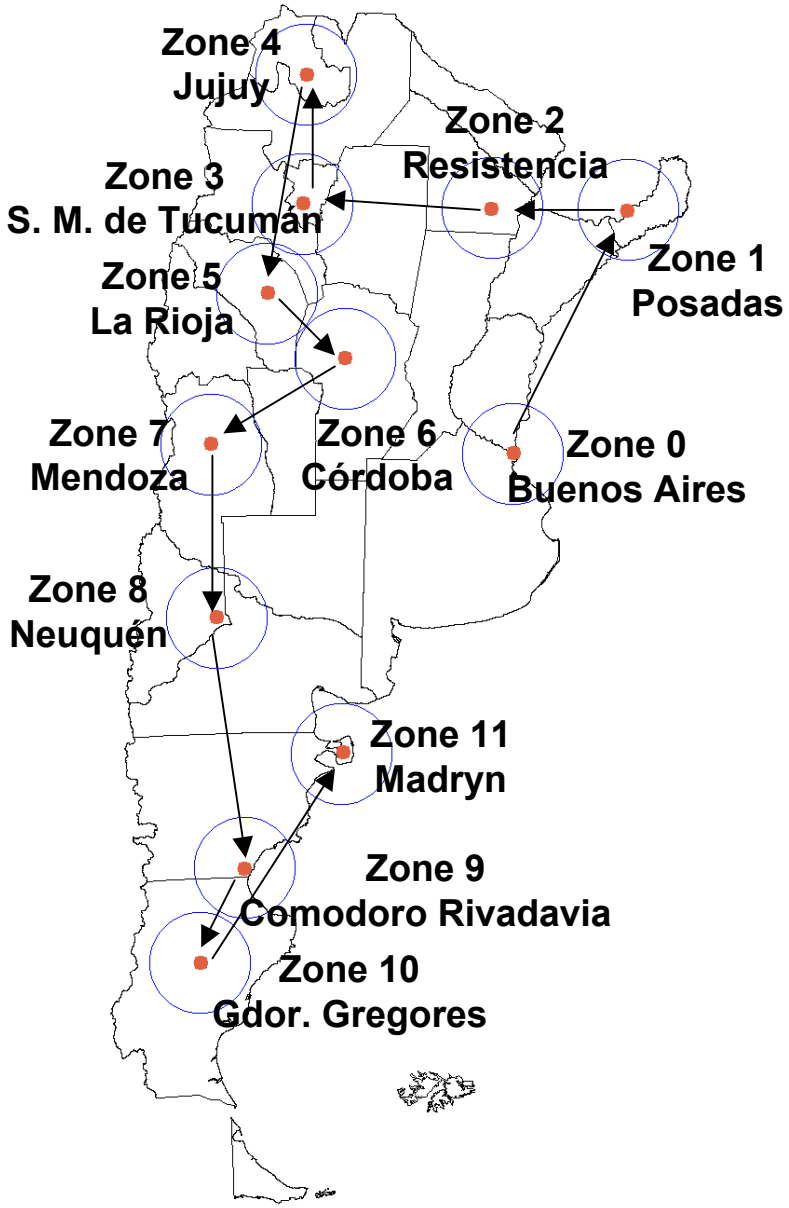
3-2-1 ALI Composite

The EOS AM Constellation Alignment for 11/21/00 Launch



AM Constellation Descending Orbit Ground Tracks





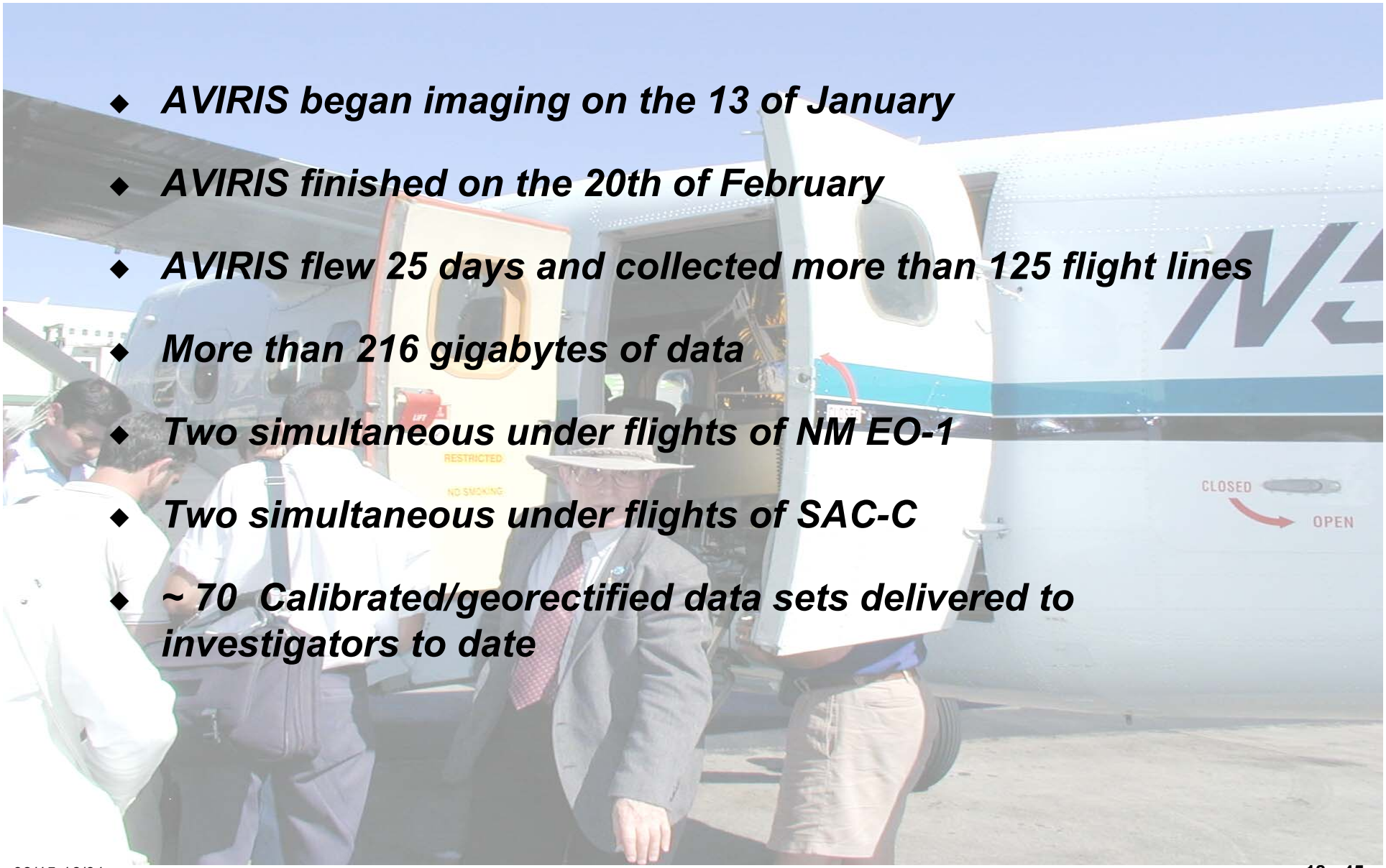
Argentina Validation Site Zone Map

for AVIRIS and EO-1/SAC-C overflights

Buenos Aires

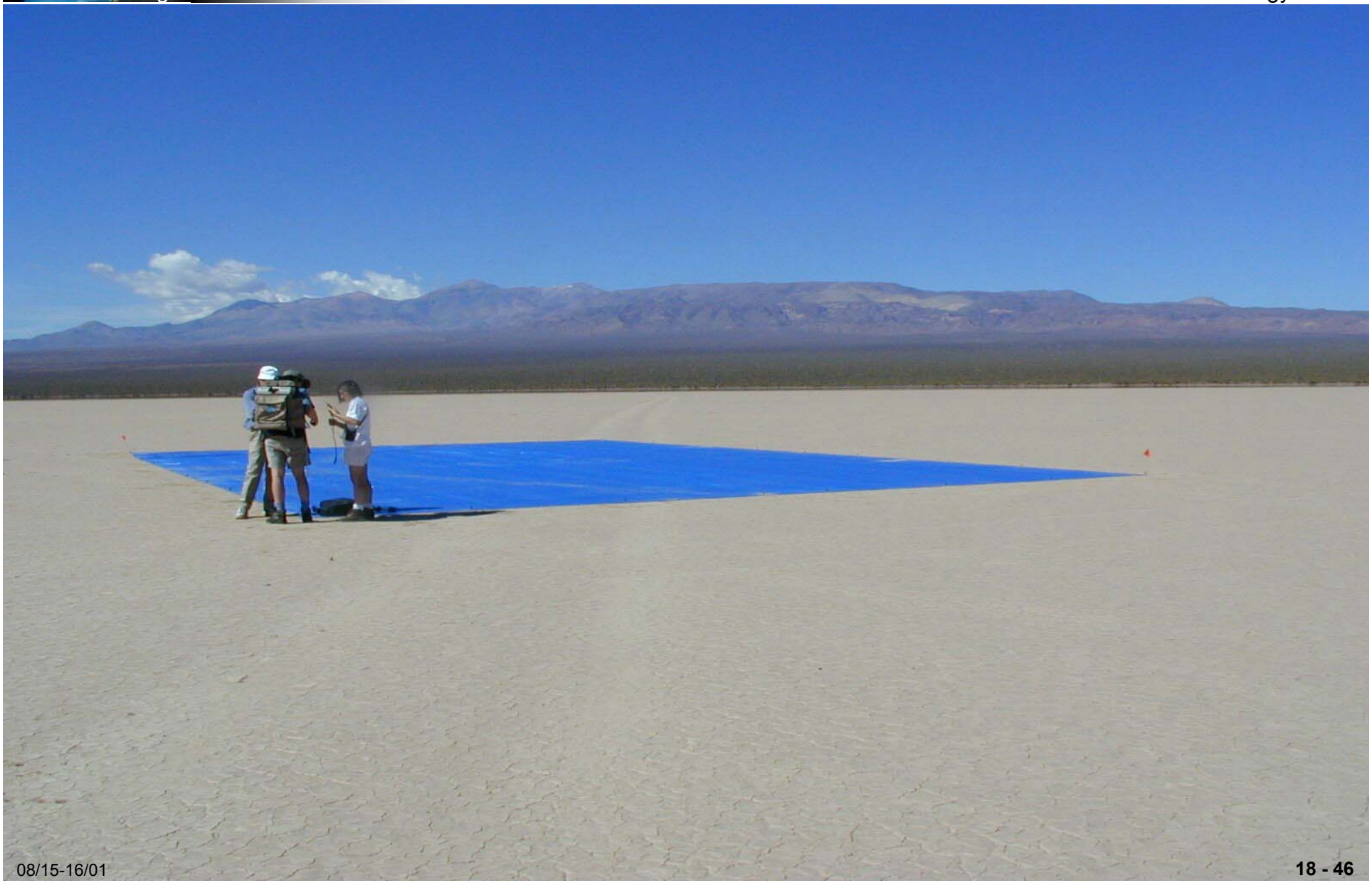
Buenos Aires
Pan Band

AVIRIS Argentina 2001

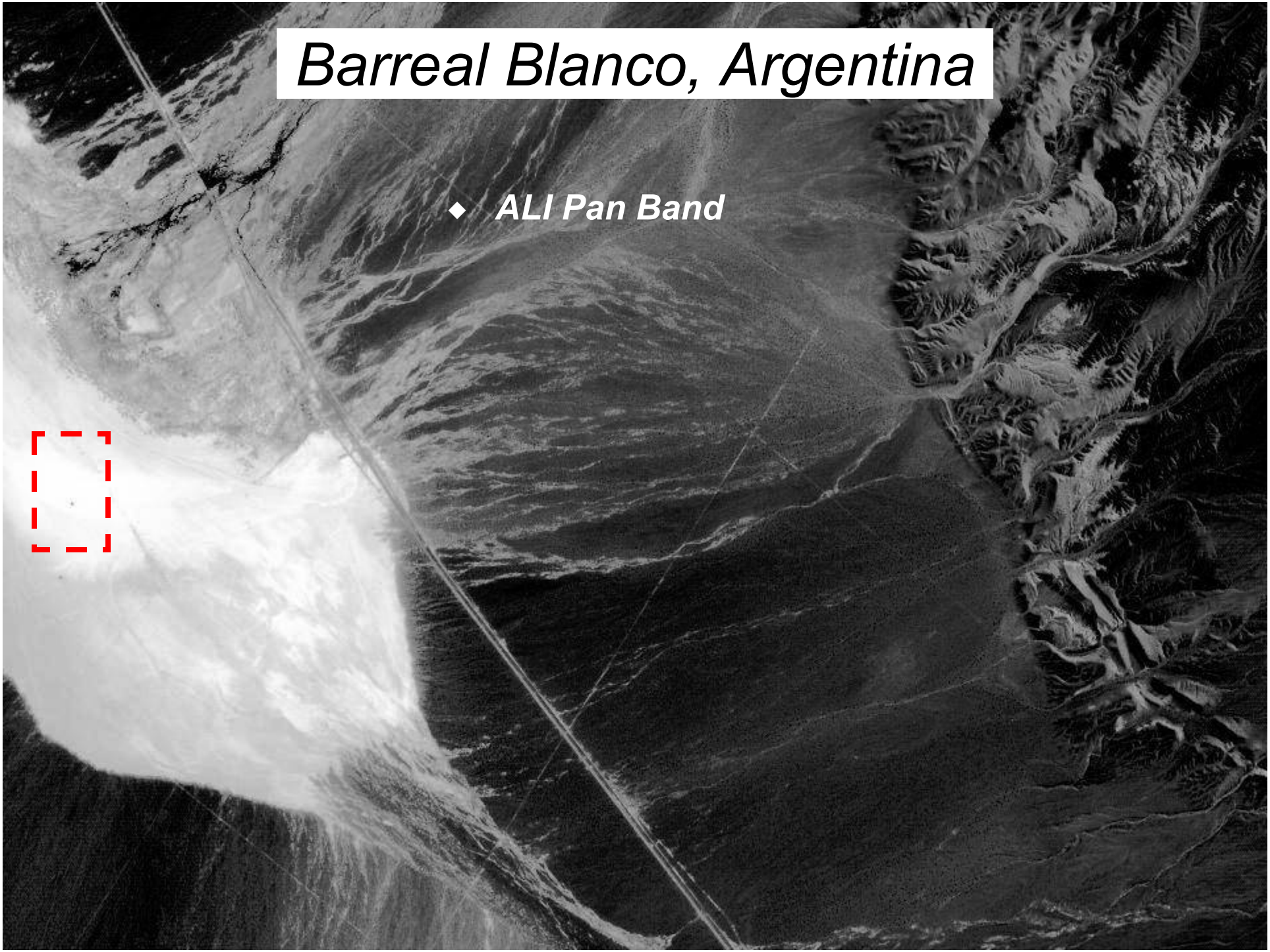


- ***AVIRIS began imaging on the 13 of January***
- ***AVIRIS finished on the 20th of February***
- ***AVIRIS flew 25 days and collected more than 125 flight lines***
- ***More than 216 gigabytes of data***
- ***Two simultaneous under flights of NM EO-1***
- ***Two simultaneous under flights of SAC-C***
- ***~ 70 Calibrated/georectified data sets delivered to investigators to date***

Barreal Blanco, Argentina



Barreal Blanco, Argentina

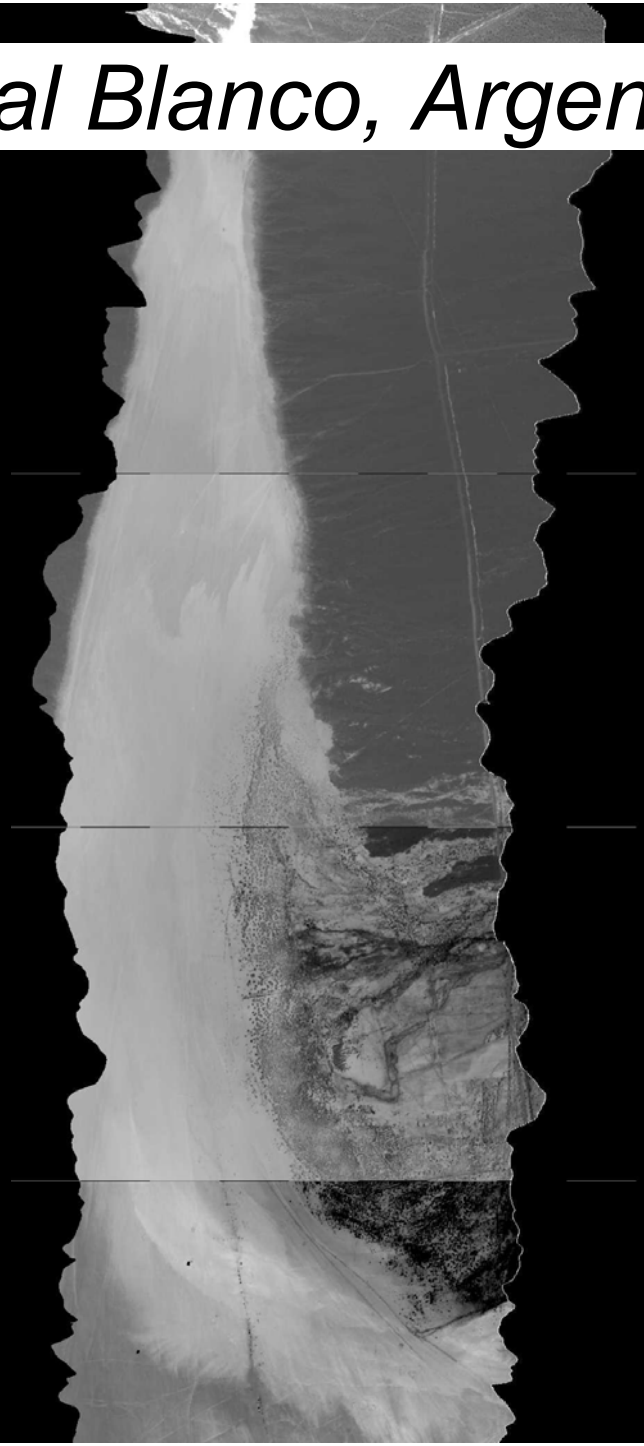

Barreal Blanco, Argentina
ALI Pan Band

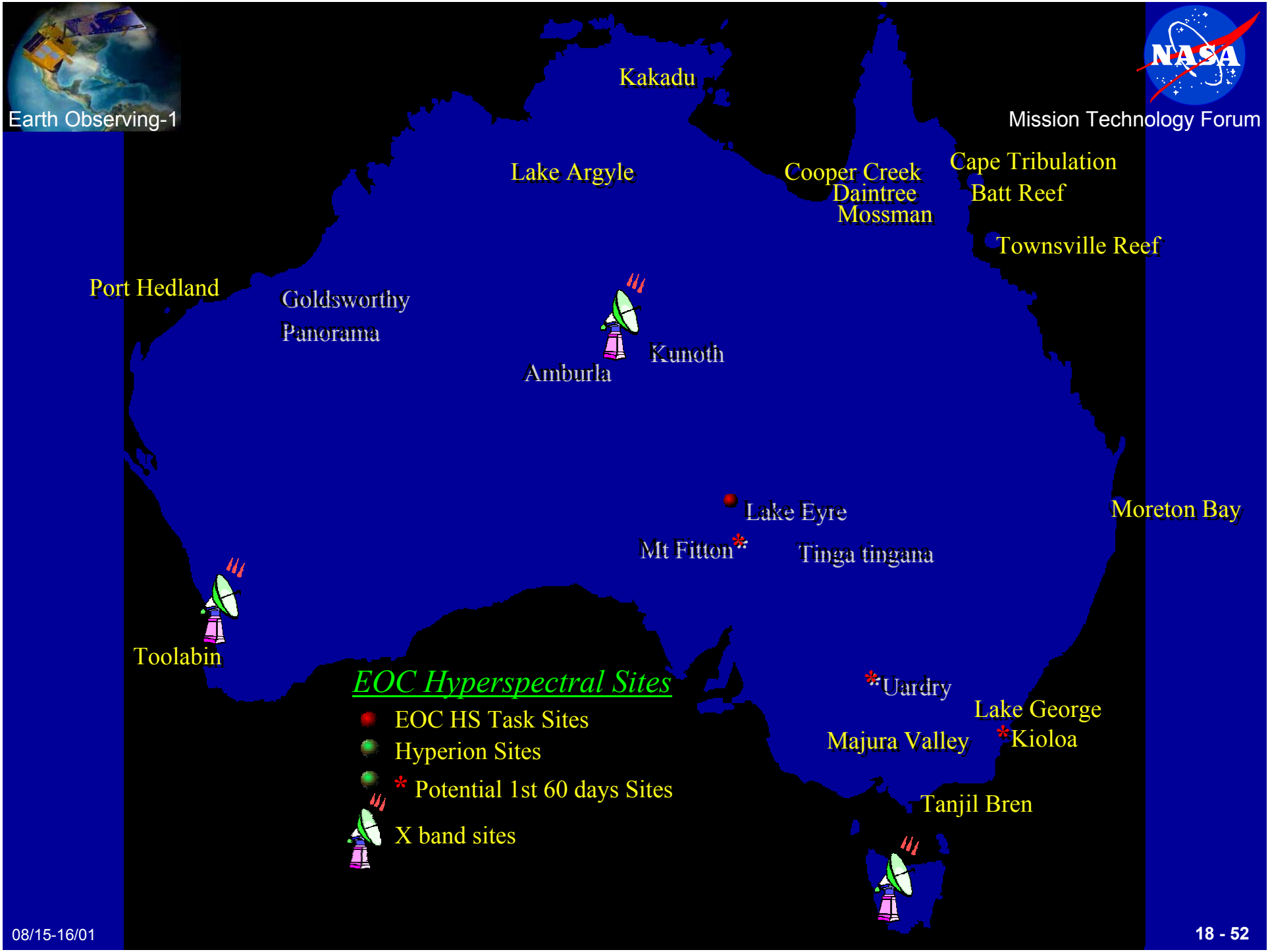
Barreal Blanco, Argentina

- ***Hyperion Image***

Barreal Blanco, Argentina

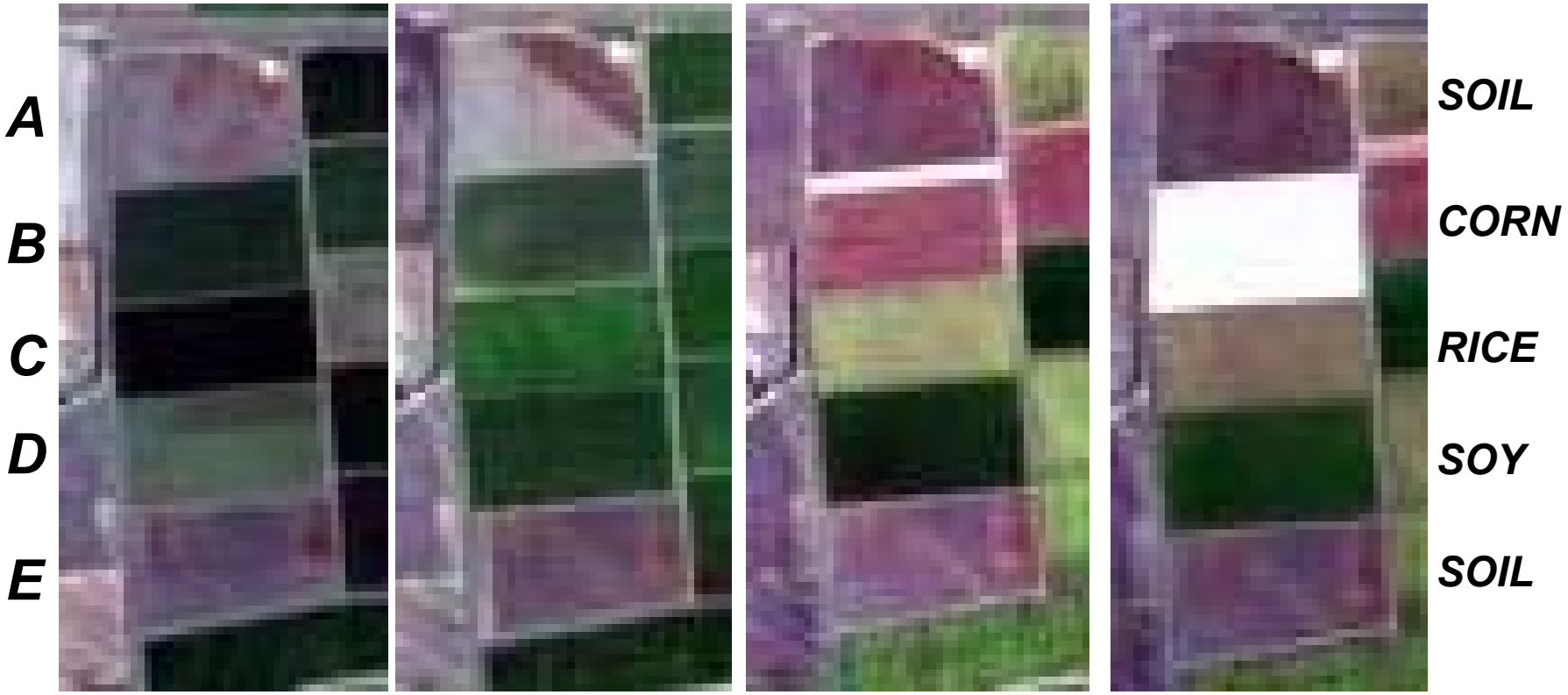
- ***AVIRIS Geometrically-corrected flight line***




Kakadu
Lake Argyle
Cooper Creek
Daintree
Mossman
Cape Tribulation
Batt Reef
Townsville Reef
Port Hedland
Goldsworthy
Panorama
Amburla
Kunoth
Lake Eyre
Mt Fitton*
Tinga tingana
Moreton Bay
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

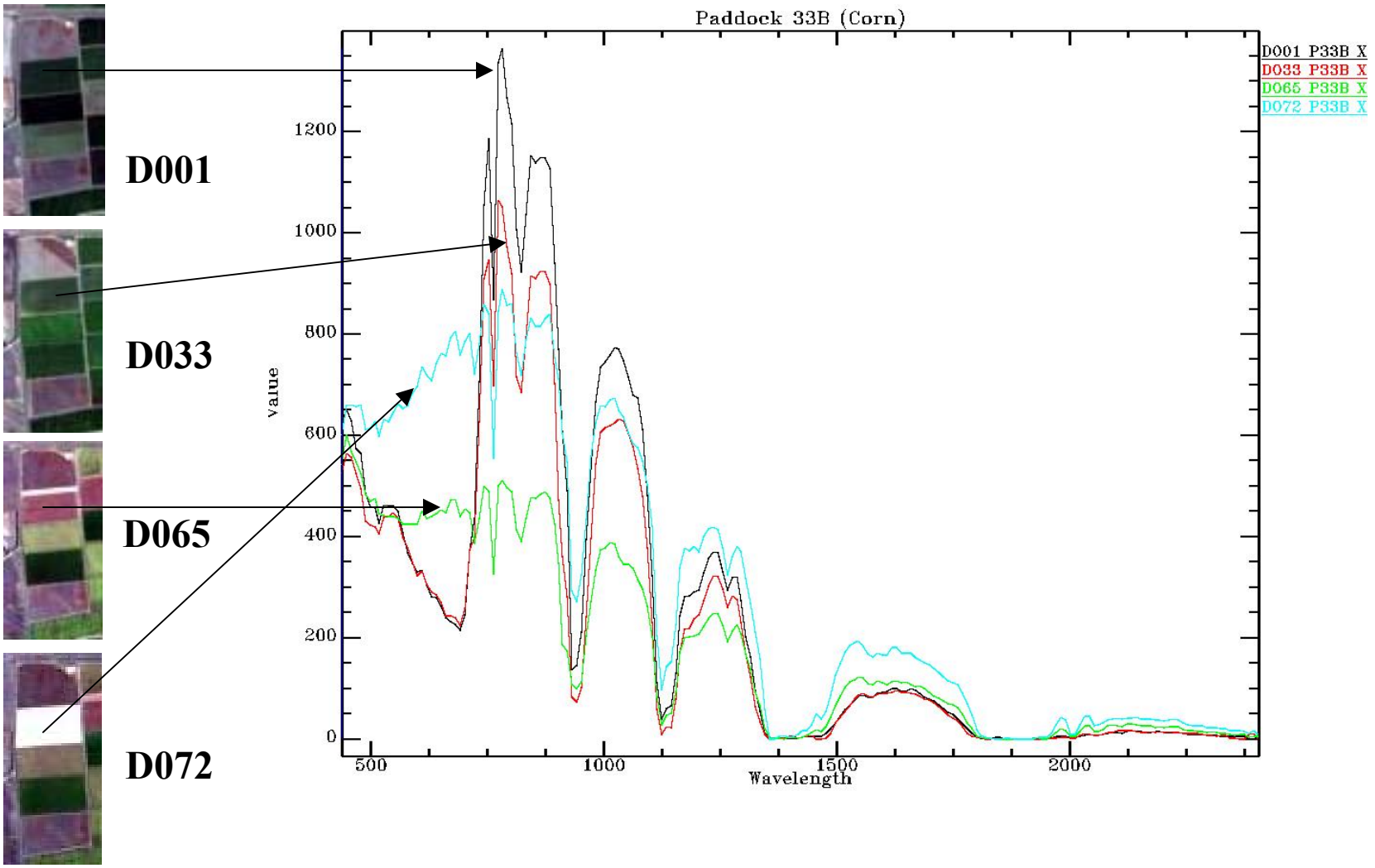
Temporal Sequence of Hyperion Images

Coleambally Irrigation Area



Julian calendar day of 2001

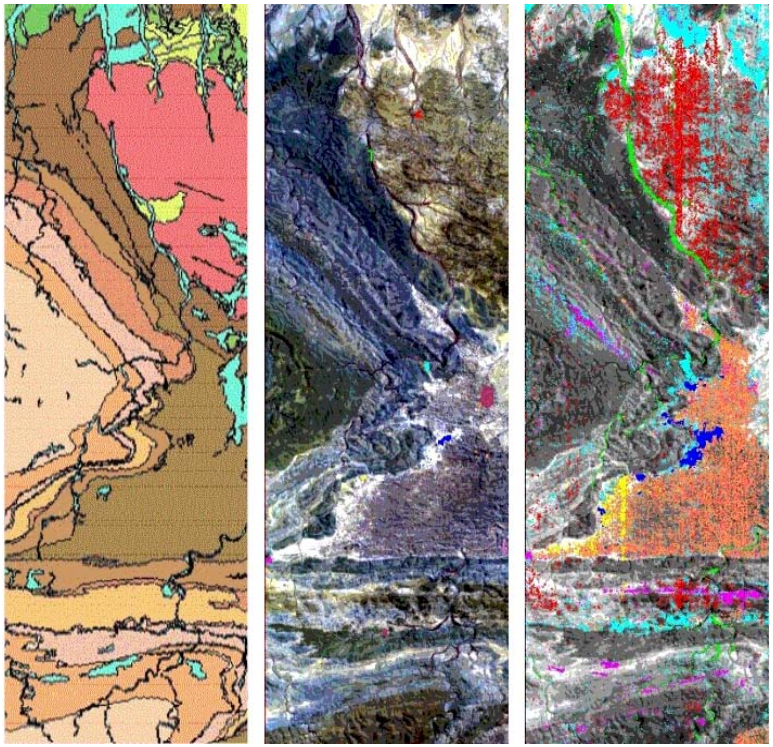
Corn (Paddock 33B)

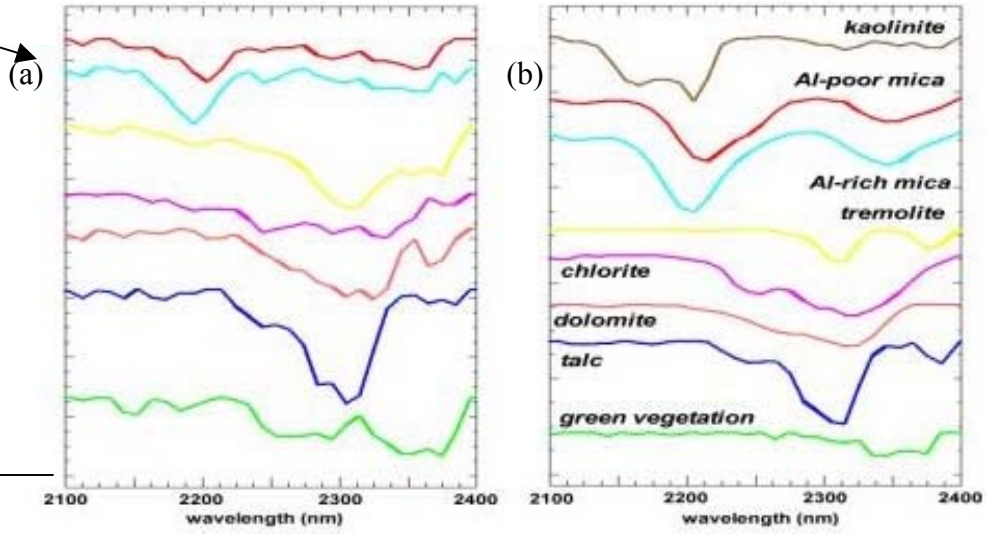


Hyperion Maps Mt. Fitton Geology

Hyperion-based apparent reflectance compares with library reference spectra

(1) (2) (3)





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

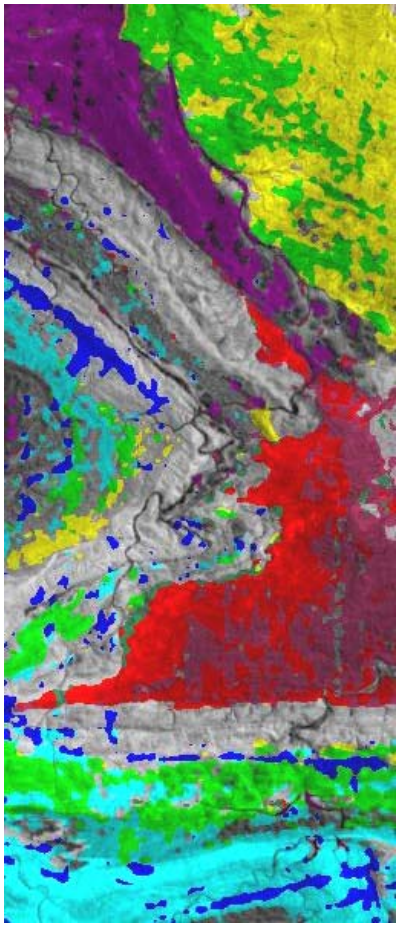
(3) Hyperion surface composition map using SWIR spectra above

Courtesy of CSIRO, Australia

Hyperion Maps Mt. Fitton Geology

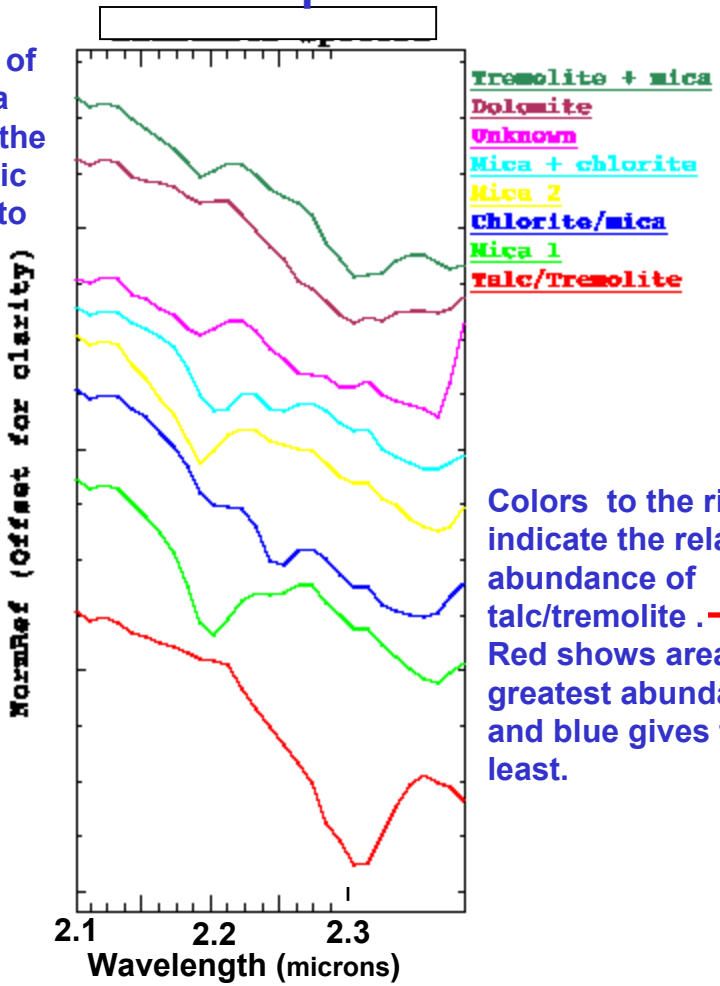
Automatic mineral mapping algorithm creates, in 30 seconds, a quick-look mineral map (left & centre). More precise detail is on right. *(Courtesy of CSIRO Australia)*

Mineral Map



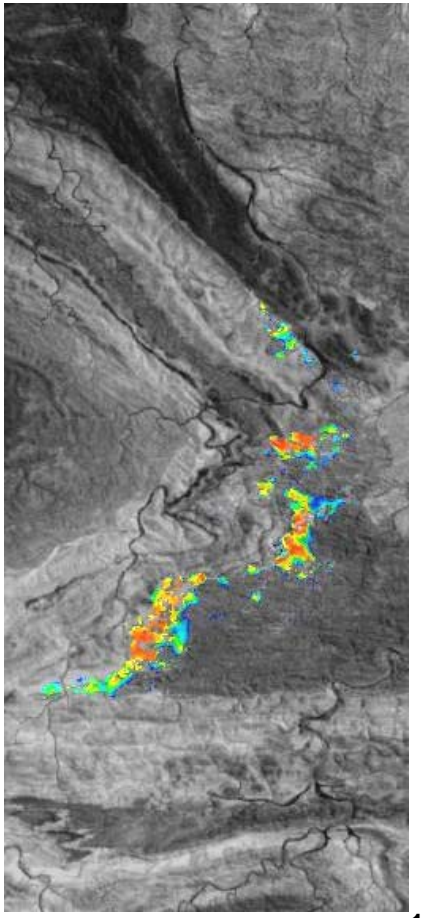
Colors of spectra match the thematic image to left.

Mineral Spectra



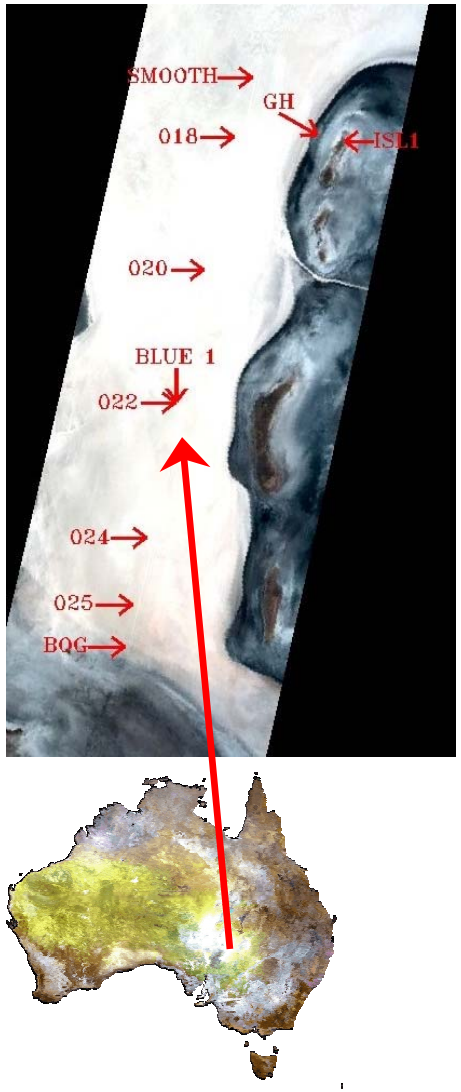
Colors to the right indicate the relative abundance of talc/tremolite . Red shows areas of greatest abundance and blue gives the least.

Detailed Talc-Tremolite Map



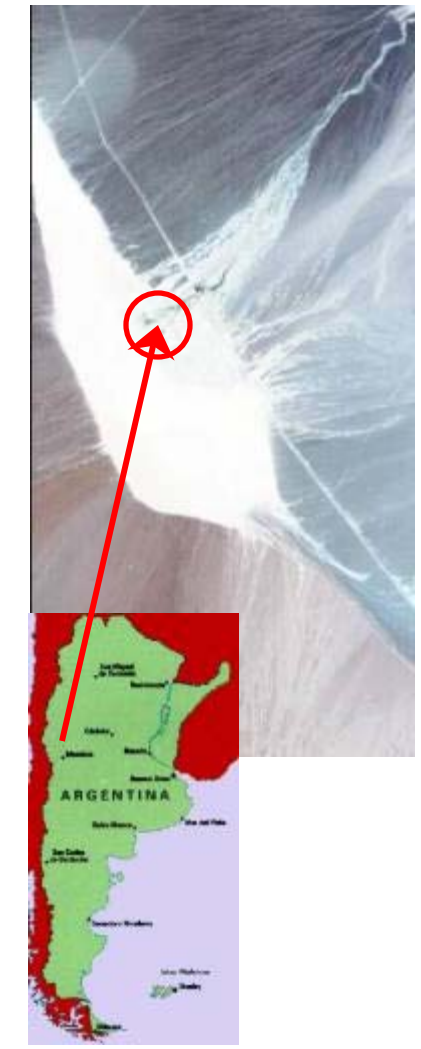
Desert Sites Used for Vicarious Calibration

Lake Frome



RR Valley

Arizaro/Barreal Blanco



Hyperion Addresses a Broad Range of Issues & World-Wide Sites

Forests

Canada

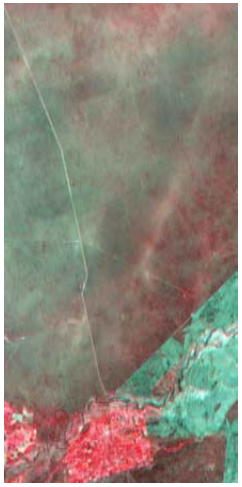
Agriculture

Australia

Minerals

United States

Grasslands



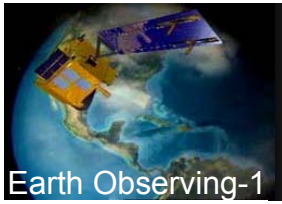
Argentina

Glaciers

Antarctica

Deserts

Sahara



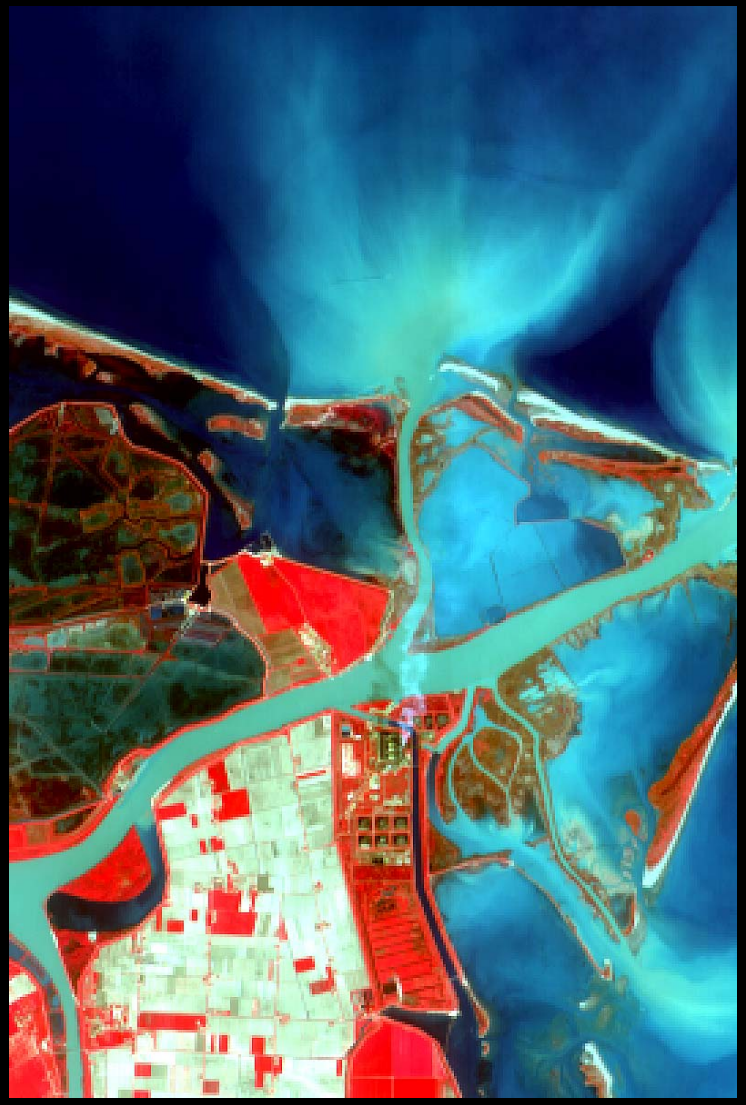
Example Science Validation Study

- ***Applications and Validation of EO-1 Data for Oceanography, Pollution, Urban Mapping***
  - ***Michael Abrams, NASA/Jet Propulsion Lab, Pasadena, CA***
  - ***Dr. Remo Bianchi National Research Council,Rome, Italy***
  - ***Dr. Luigi Alberotanza National Research Council,Venice, Italy***

April 3, 2001 MODIS Image

Venice Field Site

4/4/01 ALI 5-4-3 RGB Image



4/4/01 ALI 5-4-3 RGB Image

4/4/01 ALI 5-4-3 RGB image

Mouth of Po River