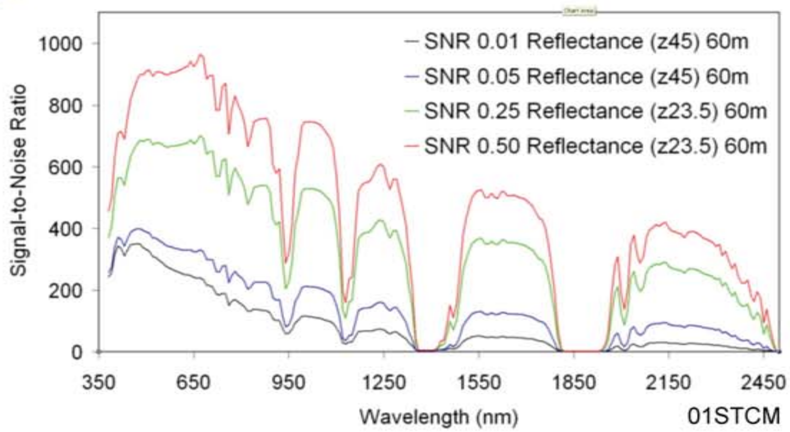
GSFC Activities in Support of HyspIRI

Betsy Middleton (NASA/GSFC)

Petya Campbell (NASA/UMBC)

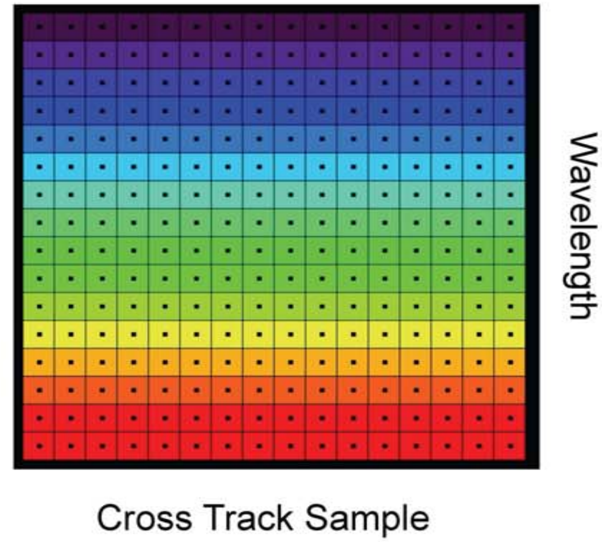
HyspIRI: Building on NASA Hyperion Technology Demonstration

SNR > 10X



01STCM B.36.1.1

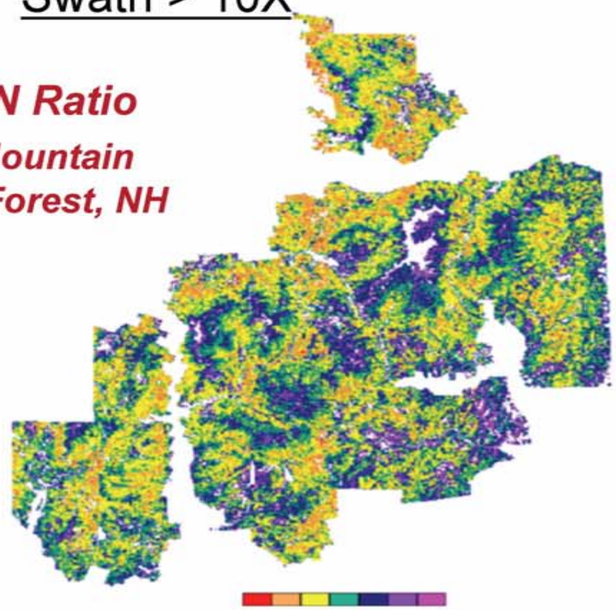
Uniformity > 10X



Swath > 10X

Soil C:N Ratio

White Mountain National Forest, NH



Global Coverage >> 10X

Earth Observing-1 (EO-1) Mission

EO-1 was designed to flight validate technologies and operational approaches applicable to future Earth observing missions. Launched on November 21, 2000, it is currently in its 9th year, with more than 40,000 scenes in archive.

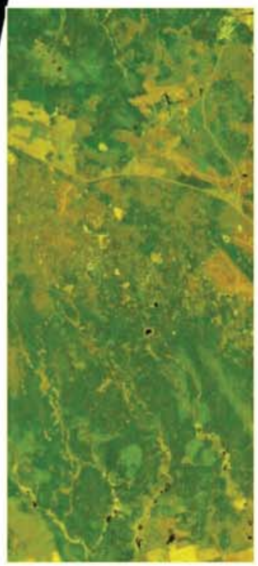
http://eo1.gsfc.nasa.gov/

ALI		Hyperion
Band designations	**Band Names (wavelength, µm)**	
Pan	Pan (0.48 – 0.69)	Continuous Spectra 0.4 – 2.4 µm 242 Bands Bandwidth: 10nm
Blue	MS-1p (0.433 – 0.453)	
	MS-1 (0.450 – 0.515)	
Green	MS-2 (0.525 – 0.605)	
Red	MS-3 (0.633 – 0.690)	
NIR	MS-4 (0.775 – 0.805)	
	MS-4p (0.845 – 0.890)	
SWIR	MS-5p (1.20 – 1.30)	
	MS-5 (1.55 – 1.75)	
	MS-7 (2.08 – 2.35)	
Spatial Resolution	Pan: 10m, MS: 30m	30m
Swath width	37km	7.5km

Heritage: EO-1 Hyperion Op's/Analysis

addresses a broad range of issues and world-wide sites

Forests



Canada

Minerals

United States

Grasslands

Argentina

Glaciers

Antarctica

Deserts

Sahara

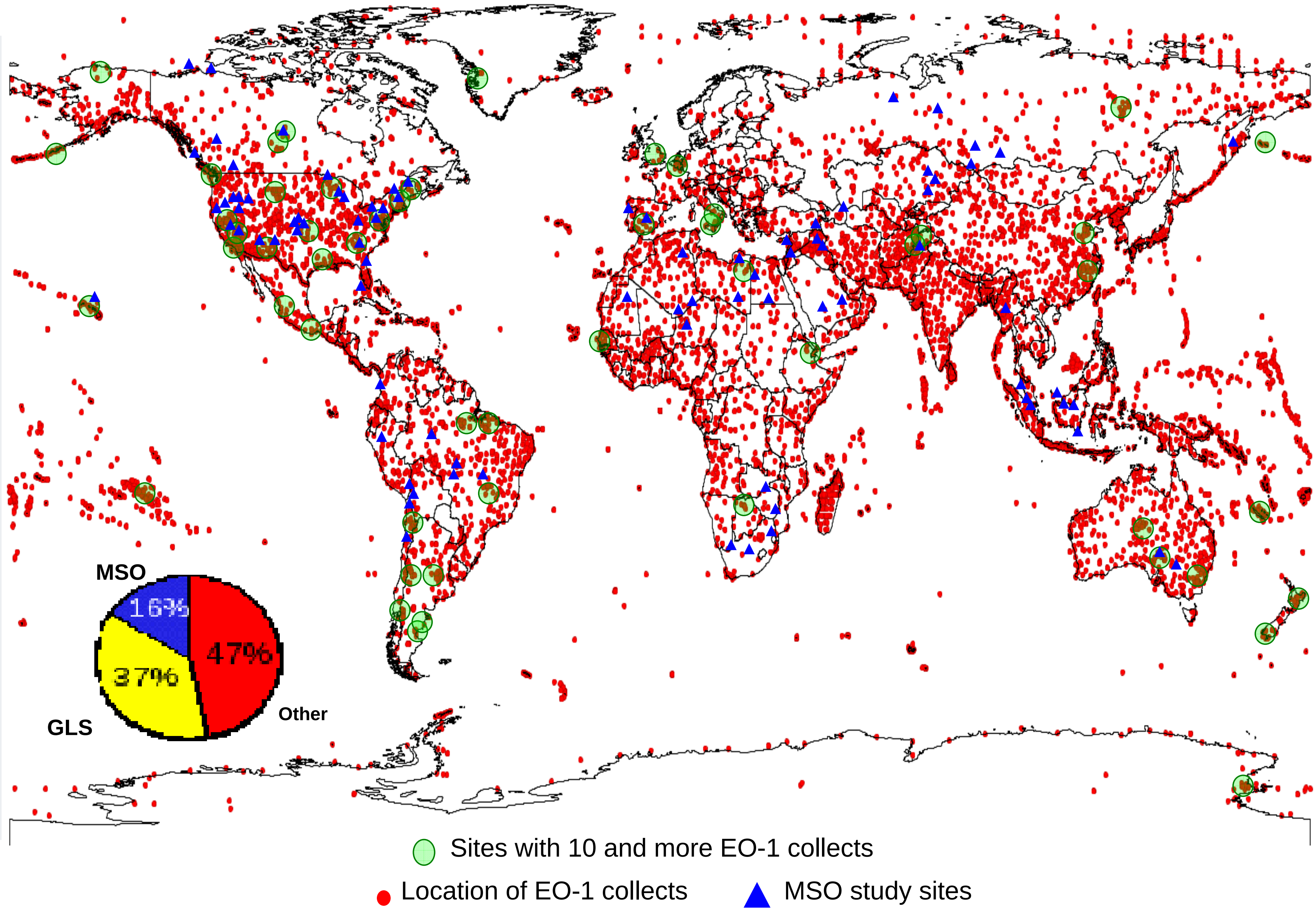
Agriculture

Australia

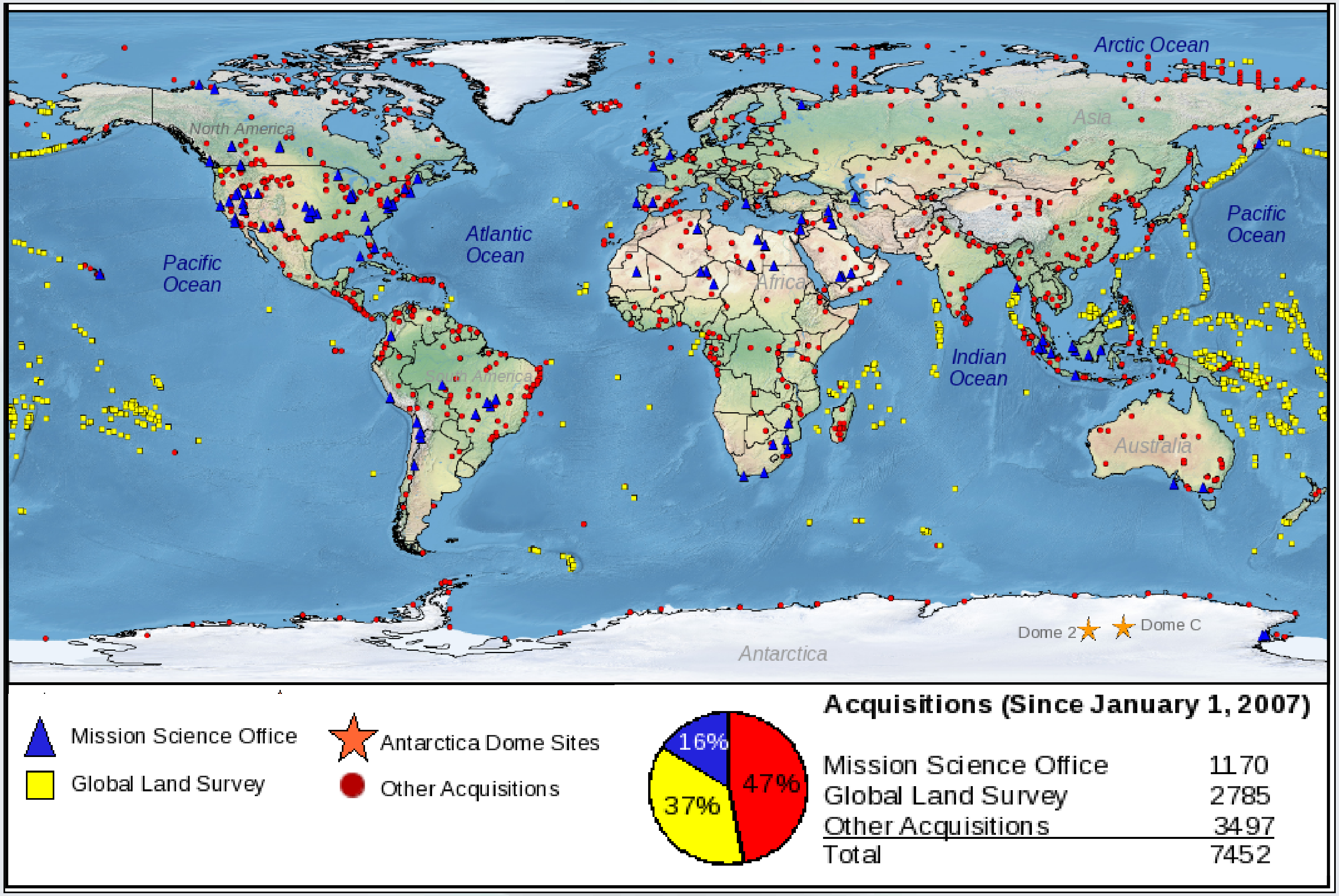
EO-1 2009 Goals towards enabling HyspIRI

- **Providing spectroscopy data for sensors inter-calibration;**
- **Generating Validation Datasets – validation of other sensors response and for validation of science products;**
- **Developing new EO-1 MSO science level products;**
- **Automated Tools & Intelligent Payload Module (IPM)– related support for data throughput;**
- **Rapid Remote Sensing and SensorWebs for Disaster response – fire, flood, volcanoes;**
- **Sources of high spectral resolution data;**
- **Hyperion applications: Discrimination of land cover types and vegetation species composition (classifications), Spectral un-mixing, Canopy Water content and Foliar chemistry, etc.**

To date, over 42500 scenes have been acquired, 2001-2009



EO-1 acquisitions during 2007-2009



These acquisitions could be summarized into three main categories: Science and disaster response, Global Land Survey (GLS2005 and GLS2010), and Calibration/Validation collects

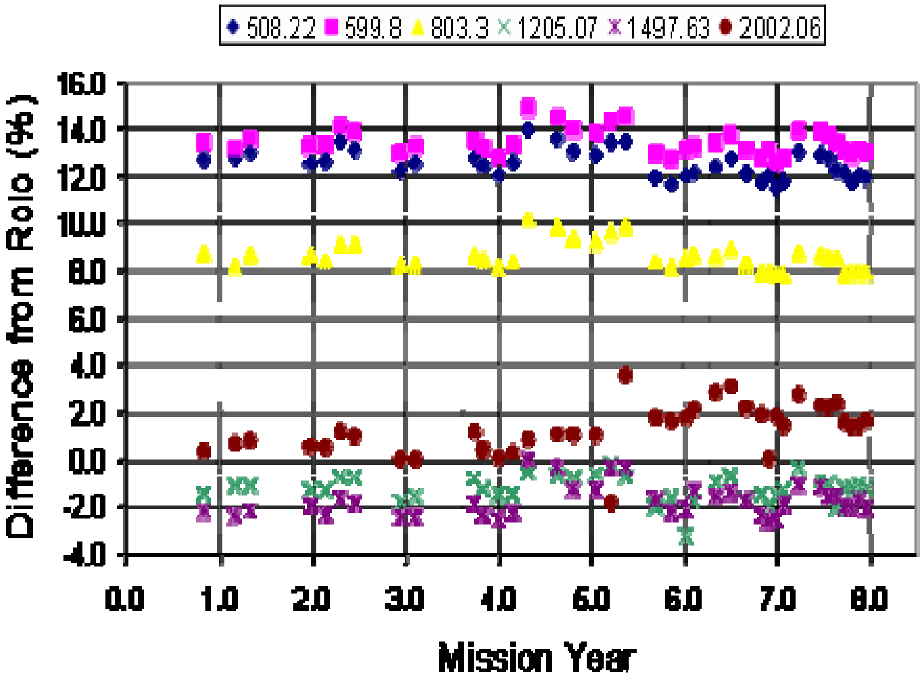
Calibration Efforts

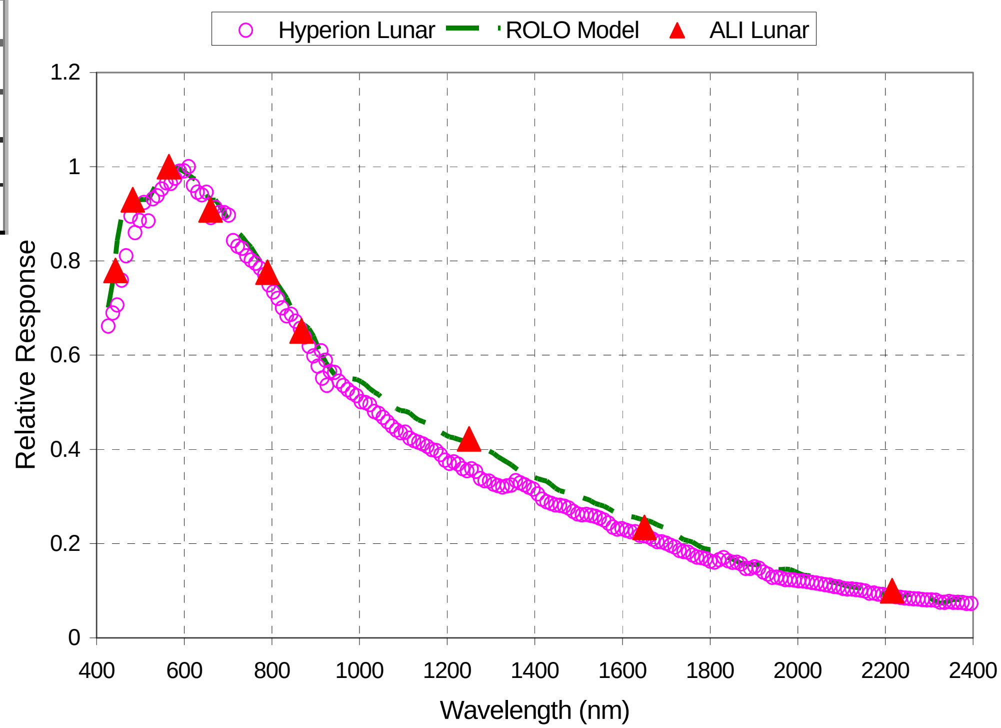
sensor inter-comparisons

Validation Activities

evaluate products

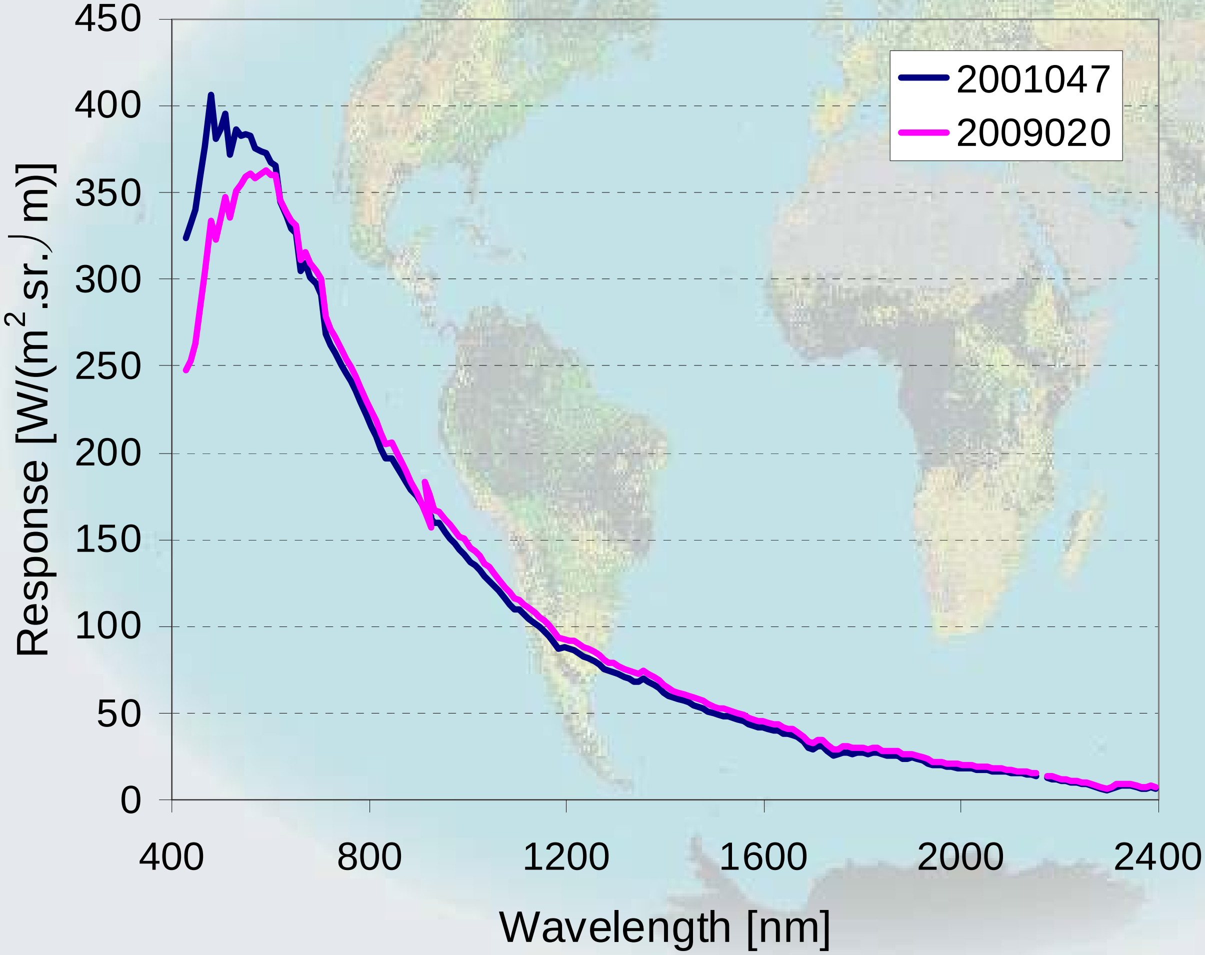
Comparison of the Hyperion integrated lunar responses with the USGS ROLO Lunar model





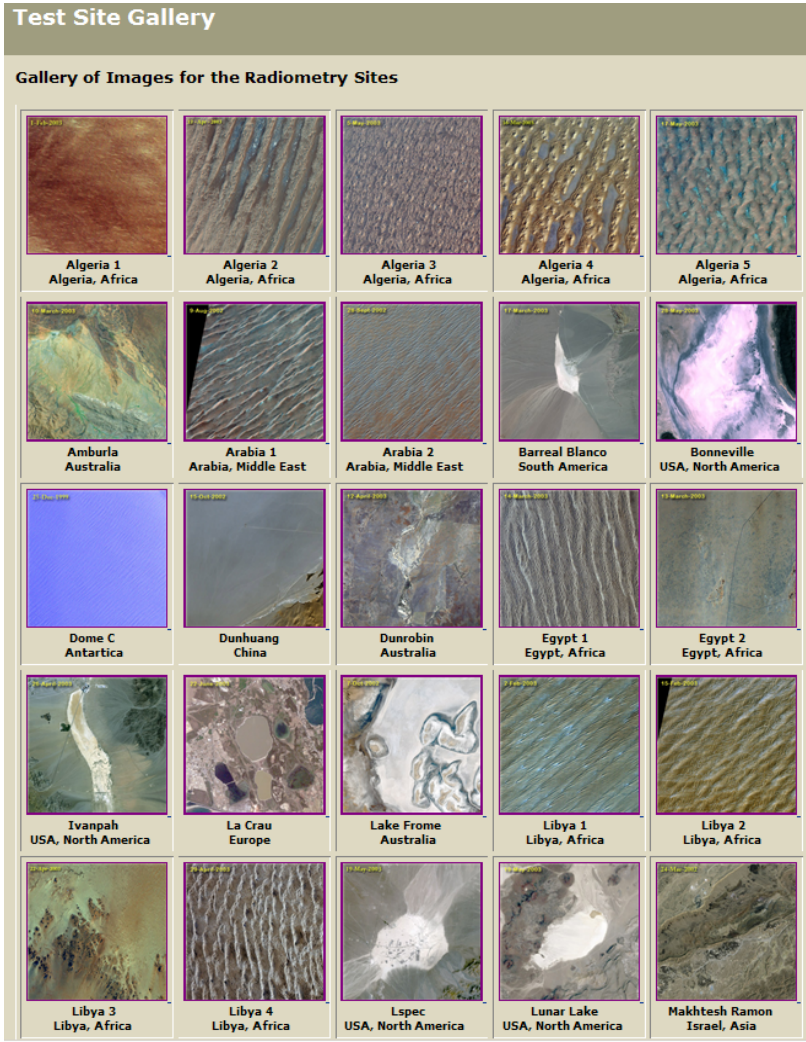
The Hyperion response has remained stable over the last eight years

Solar Panel Spectra



Spectra of the solar panel show large degradation in the shorter wavelengths

Cal/Val Targets: Repeated Collections Coordinated by Committee on Earth Observing Satellites (CEOS/WGCV/IVOS)



CEOS/WGCV Calibration Sites

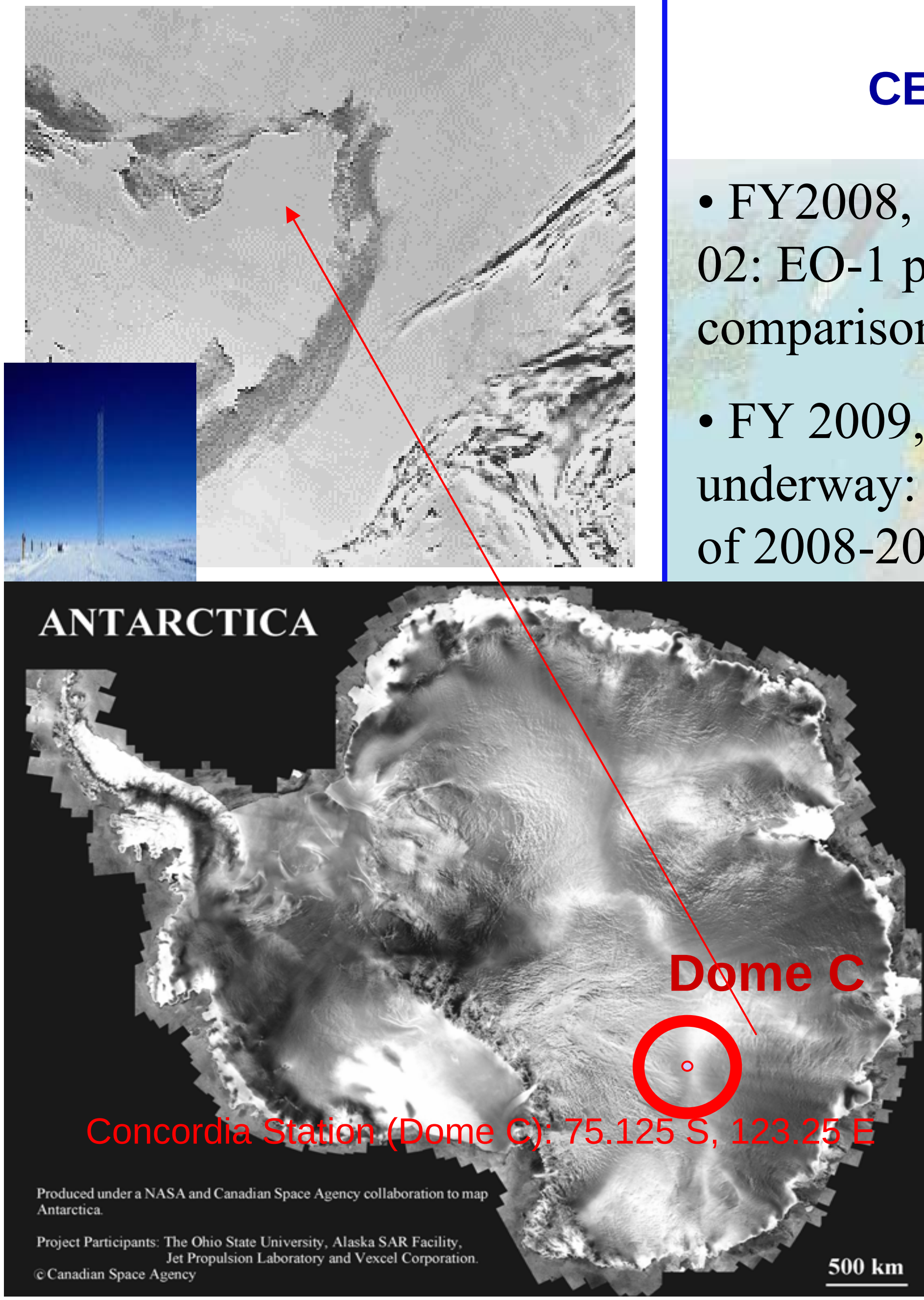
1 Tuz Golu, Turkey * (priority)
2 Frenchman Flat, USA
3 La Crau, France (only suitable for high resolution)
4 Dunhuang, China
5 Railroad Valley, USA
6 Ivanpah playa, USA
7 Negev, Israel
8 Libya 4
9 Mauritania 1
10 Mauritania 2
11 Algeria 3
12 Libya 1
13 Algeria 5

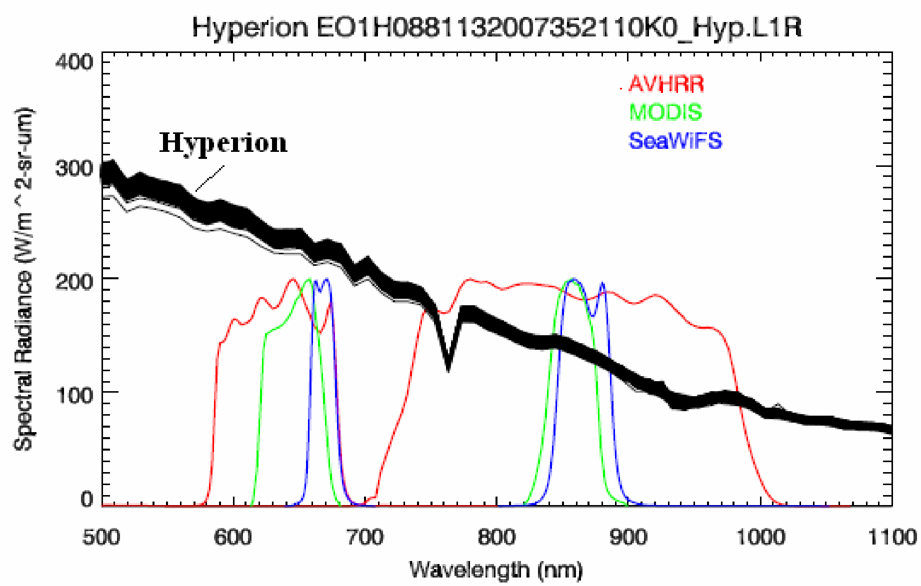
USGS: World-wide Test Sites for Sensor Characterization

QA4EO A QUALITY ASSURANCE FRAMEWORK FOR EARTH OBSERVATION CEOS GEO

CEOS's *Dome C 2008-2009 Inter-comparison*

- FY2008, WGCV Pilot study for GEO Task DA-06-02: EO-1 participated by contributing data for inter-comparison of AVHRR, MODIS and SeaWiFS.
- FY 2009, CEOS Dome C Instrument comparison underway: As part of this campaign, during the winter of 2008-2009 EO-1 collected a number of new images.





EOS Validation Core Site Data

	ARM CART *	Barton Bendish	Bondville *	BOREAS NSA *	BOREAS SSA BERMS *	H. J. Andrews LTER *	Metolius/Cascades	Harvard Forest LTER *	Howland *	Ji-Paraná (Jaru - LBA) *	Jornada LTER	Konza Prairie LTER *	Krasnoyarsk *	Mandalgobi	Maricopa Ag. Center	Mongu (SAFARI 2000) *	Walnut Gulch (San Pedro)	Sevilleta LTER *	Skukuza (SAFARI 2000)	Tapajos (Santarém LBA) *	Uardry	USDA BARC *	Virginia Coast Reserve	Walker Branch	Park Falls LTER *	Barrow	Lake Tahoe *	Chang Bai Shan *	Mead	St. Petersberg	Lindenberg	Grand Morin *	Sky Oaks
Satellite Data																																	
MODIS 200x200km Subsets																												C5	C5	C5	C5	C5	C5
MODIS 7x7km ASCII Subsets																												C5	C5	C5	C5	C5	C5
ETM+	2	6	15	5	1	4		16	1	1	5	10	3	1		11	1	8	13	2	1	11	5	1	4	4	4						
IKONOS	1	1	1	4	1	3	2	7	1	2	4	4	1	1	1	2	3	5	2	2	3	3	1	1	4	1	5						
ASTER	1	1	1	1	1	1	2		3	1	2	1		1	3	7	4	2	5	1		16	1	1	4	2	12	1	1	1	1	1	1
Atmospherically Corrected ETM+			9			1		2		1		3				6		2	7	1		8	1	1	1	1							
AVHRR NDVI subsets																												P	P	P	P	P	P
SPOT-VEG NDVI subsets																												P	P	P	P	P	P
Digital Elevation Data																																	
MISR subsets																												P	P	P	P	P	P
Quickbird			P																														
Global LC Test Sites (GLCTS)																																	
GeoCover 1990's, 2000 TM, ETM+																												P	P	P	P	P	P
Aircraft Data																																	
AirMISR																																	
MODIS Quick Airborne Looks																																	
AVIRIS																																	
Data Networks																																	
AERONET																																	
FLUXNET																																	
LTER/ILTER																																	
VALERI																												P	P	P			
CEOP (GEWEX)																																	
BSRN																																	
SPECNET																																	

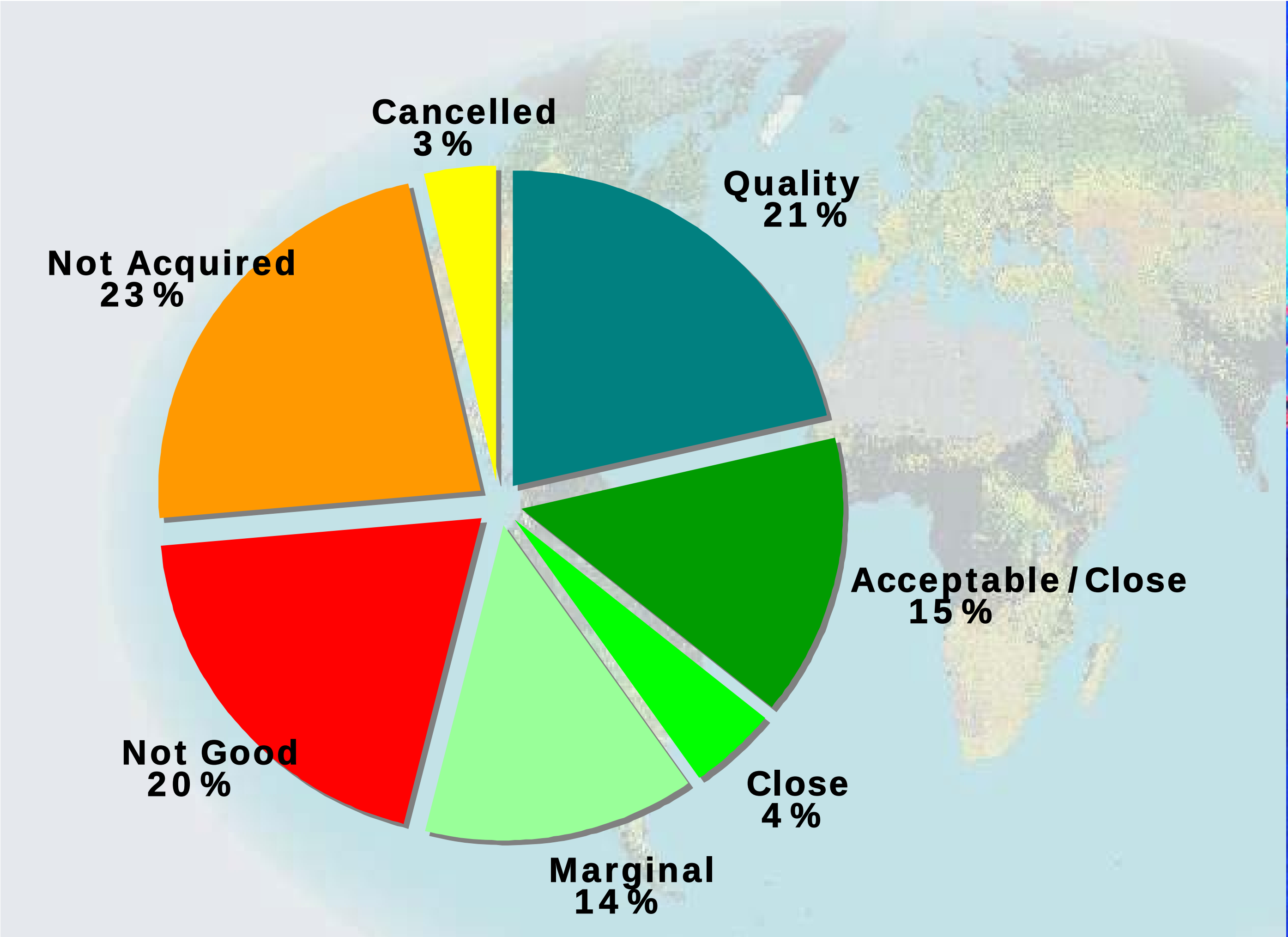
Data Location and Code Legend

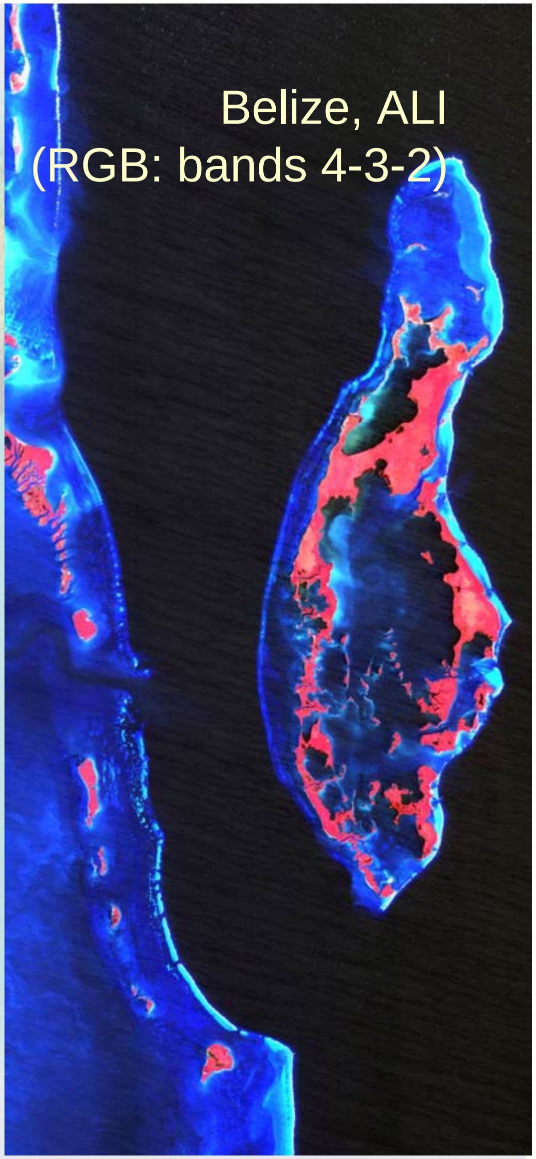
	LP DAAC
	ORNL DAAC
	GSFC
	Langley DAAC
	Univ. of Arizona
	JPL
	Active Network
C5	To be Subset with MODIS Collection 5
P	Pending data extraction
#	Number of Acquisitions Available for Site

Nickeson, J., J. Morisette, J. Privette, C. Justice, D. Wickland, 2007. Coordinating Earth Observing System Land Validation, *EOS Transactions*, 88(7)81-82.

	Site name	Latitude	Longitude	IGBP Cover Type
	I st priority			
1	**BARC- USDA ARS**	**39.03**	**-76.85**	**Broadleaf Cropland**
2	Barrow	71.322525	-156.625881	grassland
3	Bartlett Experimental Forest- New Hampshire	44.06464	-71.288077	Mixed forest
	British Colubmia, DF49	?	?	
4	**SERC**	38 53'N	-76 33' W	Mixed Hardwoods
5	Bondville	40	-88.29154	BroadleaFLX Cropland
6	Vancouver Island, British Columbia , CA	49°52’7.8”N	125°20’6.3”W	Douglas fir
7	BOREAS/BERMS SSA	53.65	-106.2001	Southern Boreal Forest
8	**Harvard Forest**	**42.53**	**-72.17**	**Northern Hrdwoods**
9	Howland Forest (main tower)- Maine	45.20407	-68.740278	Mixed forest
10	Jornada	32.6	-106.86	Shrubland/Woodland
11	Konza Prairie	39.08	-96.56	Grassland/Cereal Crop
12	Sevilleta	34.344	-106.671	Grassland/Cereal Crop
13	Wisc: NTL LTER - Park Falls	45.9454	-90.27248	Needle leaf Forest
14	ARM/CART Ponca City (28/34 Landsat)	36.77	-97.13	Agriculture (Wheat)
15	Duke Forest-hardwoods- North Carolina	35.973582	-79.10043	Mixed forest
	II ond priority			
16	Metolius/Cascades OR (Landsat 45/29)	44.452432	-121.557166	Evergreen needle leaf forest
17	Virginia (costal reserve)	37.42	-75.7	Broadleaf Cropland
18	ARM/CART SGP	36.64	-97.5	Grassland/Cereal Crop
19	ARM/CART Shider	36.93	-96.86	Grassland
20	Cascades, Springfield, IL	44.25	-122.25	forest
21	Walker, Oak Rdge, Tennessee, USA	35.96	-84.31	forest
22	WindRiverCraneSite,Washington	45.82049	-121.95191	forest
23	Québec, CA	49.69247	-74.34204	Mature site
24	Krasnoyarsk	57.27	91.6	Deciduous needleleaf
25	Yakutsk-Larch Russia	62.255	129.618889	Larix gmelinii (100-160 yrs.)
26	Zotino Russia	60.8007972	89.350806	Coniferous forest, central Siberia
27	Shortandy, Kazhstan	51.5736111	71.259722	dry step (short grass, wheat and hey)
28	St. Petersburg, Russia	59◦ 56'N	30◦18'E	Deciduous/conifer mixed forest
29	Changbaishan, China	42.4025	128.095833	Deciduous/conifer mixed forest
30	Hyytiala, Finland	61.847415	24.29477	Evergreen needleleaf forest
31	Sodankyla, Finland	67.3618611	26.637833	Evergreen needleleaf forest
32	Avignon, France	43.9163889	4.879167	Cropland and deciduous broadleaf
33	La Crau, France	43.9163889	4.879167	cropland (wheat, rice, corn, meadow)
34	Barrax, Spain	39◦3'44" N	2◦6'10" W	various crops

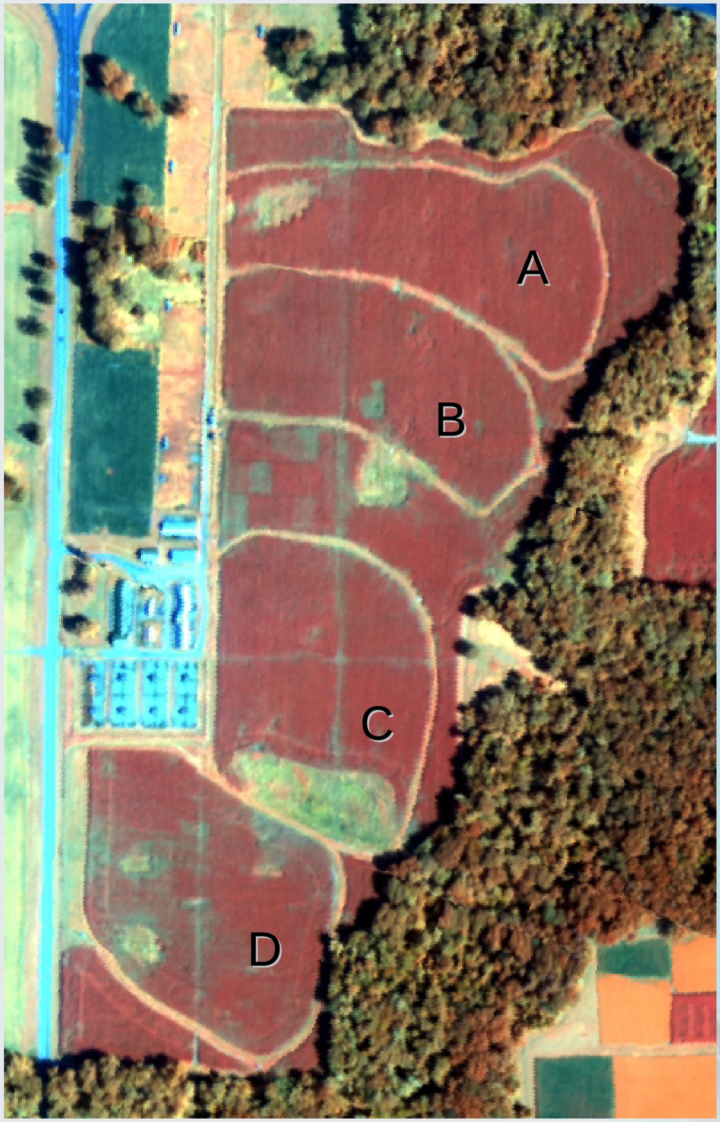
EO-1 ALI data for reefs and islands are used in the Mid-Decadal Global Land Surveys 2005 and 2010 (±2 yr)





EO-1 scenes used in the Mid-Decadal Global cover 56% of the island content of the GLS2005

Plant Growth Experiment Site at USDA Beltsville Agricultural Research Center

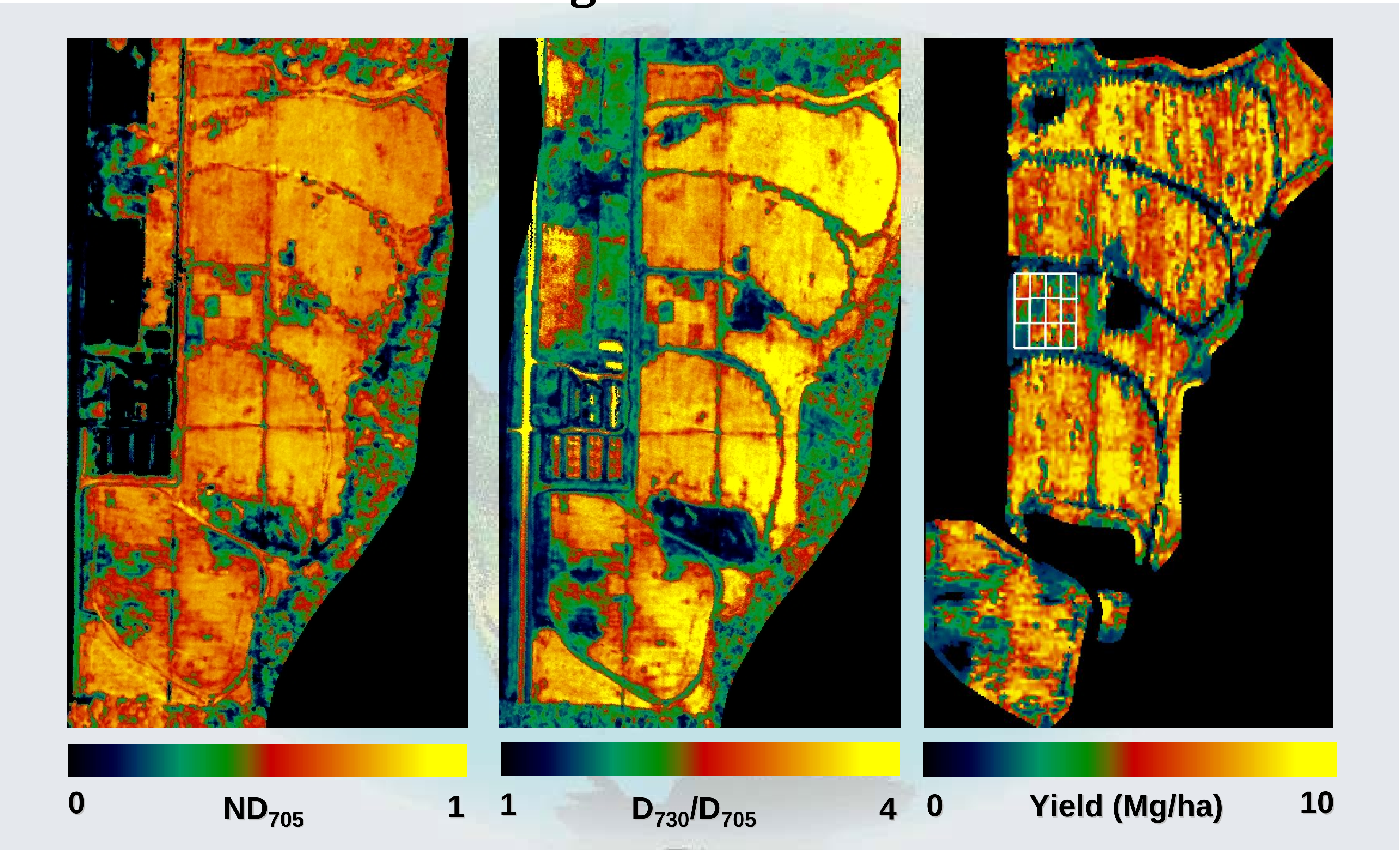


The EOS Validation Site - Located at the USDA Beltsville Agricultural Research Center is part of an intensive multi-disciplinary project entitled Optimizing Production Inputs for Economic and Environmental Enhancement (OPE).

The site has four hydrologically bound watersheds, about 4 ha each labeled as A through D which feed a wooded riparian wetland and first-order stream.

Carbon and nitrogen cycle dynamics - are being probed with a hybrid fluorescence and reflectance remote sensing approach. An intensive ground sampling protocol was initiated in 2001.

Remotely Sensed Reflectance Indices Tracking Corn Grain Yield



Biophysical Measurements

Canopy Optical Properties

Canopy Reflectance

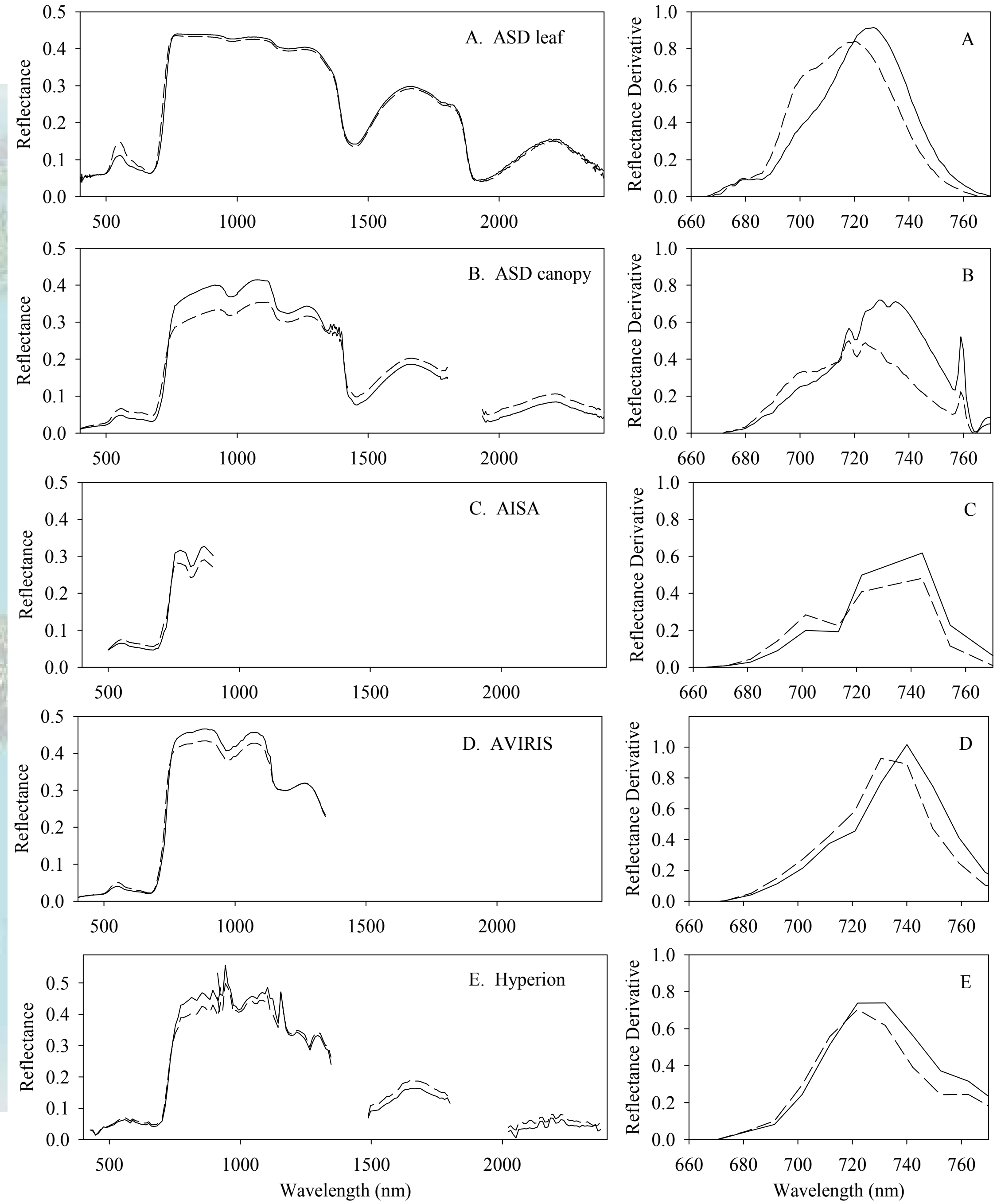
The ASD FieldSpec-Pro radiometer was used to measure radiance 1 m above plant canopies with a 22o field of view and a 0o nadir view zenith angle. The radiometer has 3 nm Full-Width at Half Maximum (FWHM) spectral resolution at a 1 nm sampling resolution.

Leaf Area Index

LAI was determined using the LI-2000 Plant Canopy Analyzer with a single above canopy and four below canopy data points at each *in situ* measurement location.

Reflectance and reflectance derivative spectra (x100) for high N (solid) and low N (dashed) field corn at five observation levels

A) leaf integrating sphere with ASD spectral radiometer,
B) above canopy at 1m with ASD spectral radiometer,
C) AISA aircraft multispectral sensor,
D) AVIRIS aircraft hyperspectral imager,
E) EO-1 Hyperion orbital hyperspectral imager.

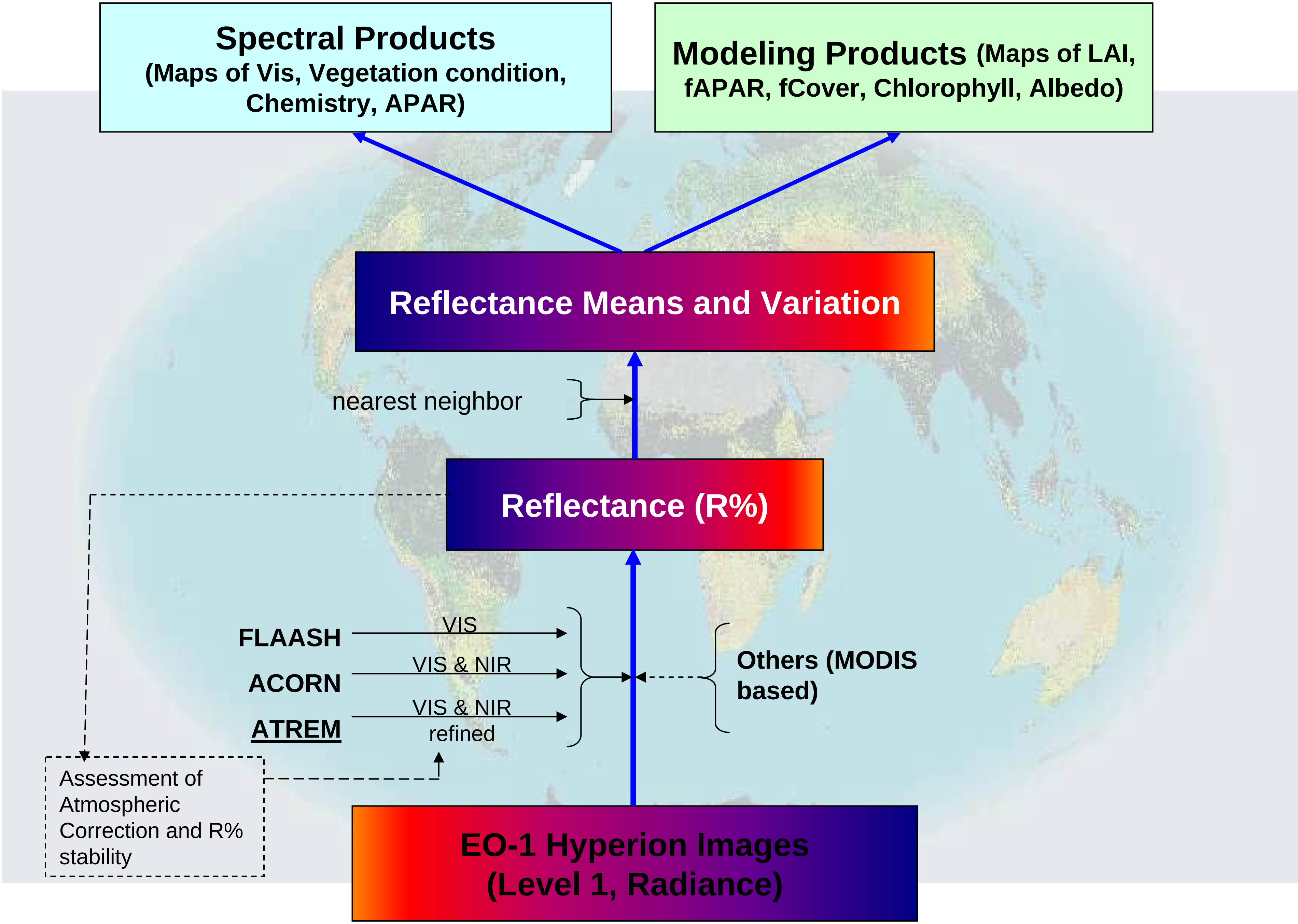


Prototyping & Evaluating Science Products

Level 2-3

EO-1 Hyperion Science Products & Tools

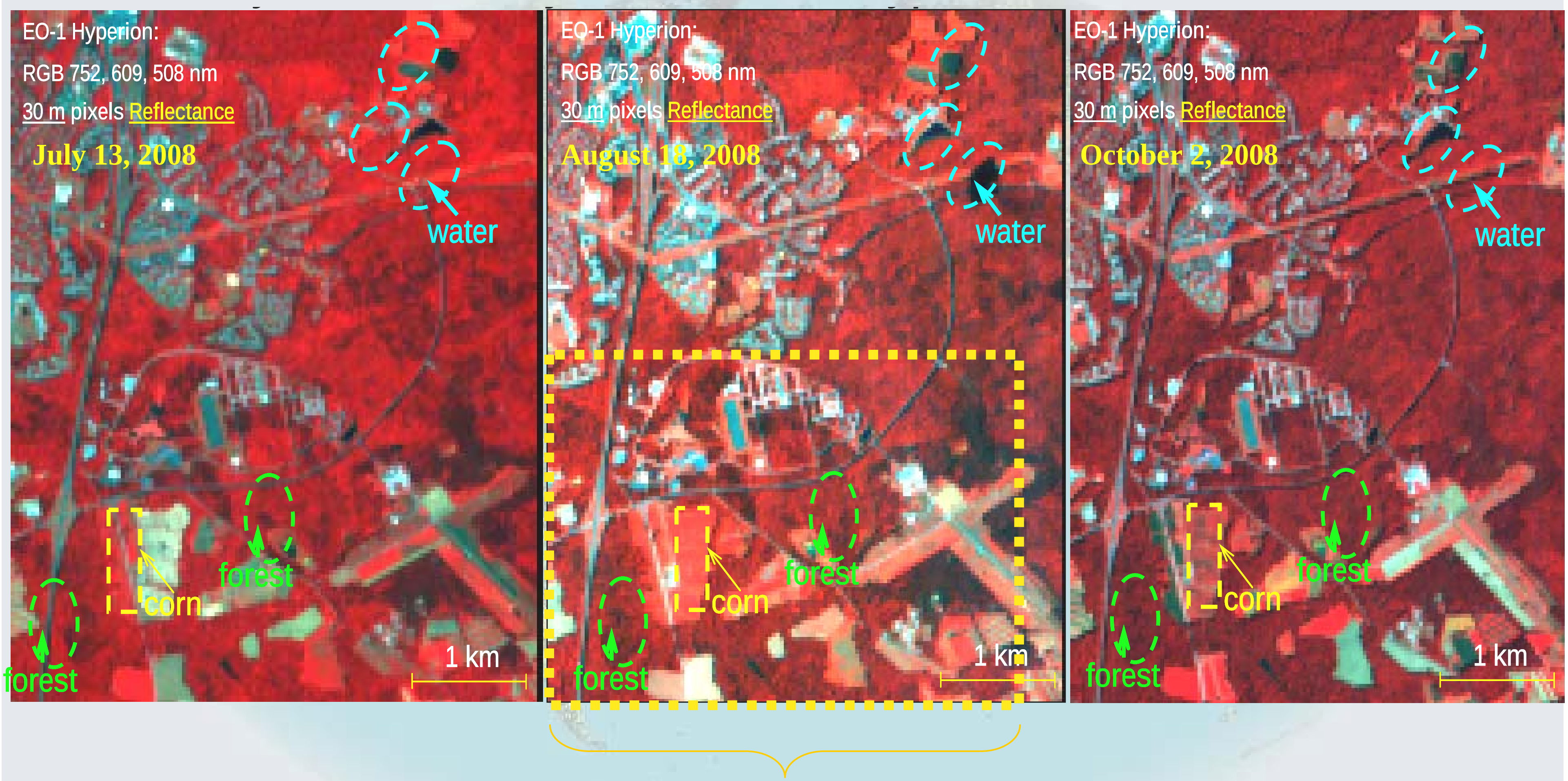
1. Reflectance (%) **
2. Vegetation spectral bio-indicators (VIs) **
3. LAI (MODIS C4, SPOT/Veg, AVHRR, MERIS, other) *
4. fPAR (MODIS, AVHRR, other) *
5. Total chlorophyll (modeled Cab) **
6. Albedo (MOD43) *
7. LUE **
8. Landsat - greenness, wetness *
9. Canopy chemistry (WGCV/LPV!)**



Spectral Products
(Maps of Vis, Vegetation condition, Chemistry, APAR)
Modeling Products (Maps of LAI, fAPAR, fCover, Chlorophyll, Albedo)
Reflectance Means and Variation
nearest neighbor
Reflectance (R%)
FLAASH
VIS
ACORN
VIS & NIR
ATREM
VIS & NIR refined
Others (MODIS based)
Assessment of Atmospheric Correction and R% stability
EO-1 Hyperion Images
(Level 1, Radiance)

Products	Approach	Outcome
Reflectance	**ACORN, ATREM and FLAASH** ? Spectral matching	Seasonal and long term trends in spectra, basis for sensors inter-comparison
LAI, fAPAR, fCover	Spectral approaches, Modeling, In collaboration with OLIVE (WGCV/LPV, F. Baret)	Seasonal trends, variation by land cover, Validate/Confirm by comparison to field data and estimates from other sensors
Foliar pigments (total chlorophyll)	Testing spectral approaches and models, OLIVE	Local variability, Seasonal and long term trends
LUE	Spectral and Modeling approaches	Seasonal dynamics, Variation by cover type
	Adjusted to 10 nm spectral trends, classifiers, un-mixing, derivatives; Approaches for confirmation / validation	Monitoring of seasonal and long term trends in foliar water, pigments and other, Monitoring of ecosystem function

Seasonal Dynamics at 30 m for Major Land Cover Types
Greenbelt, MD

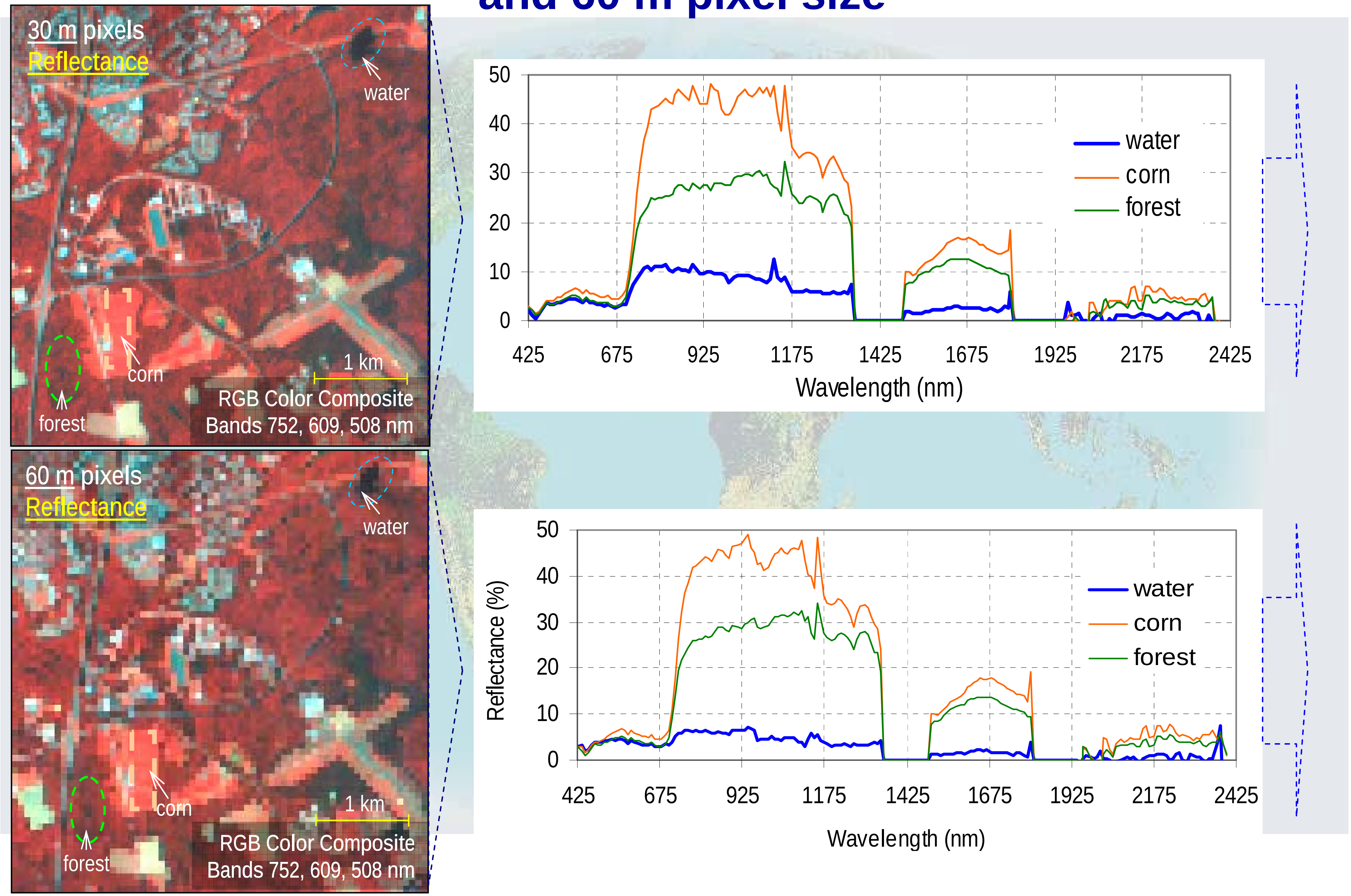


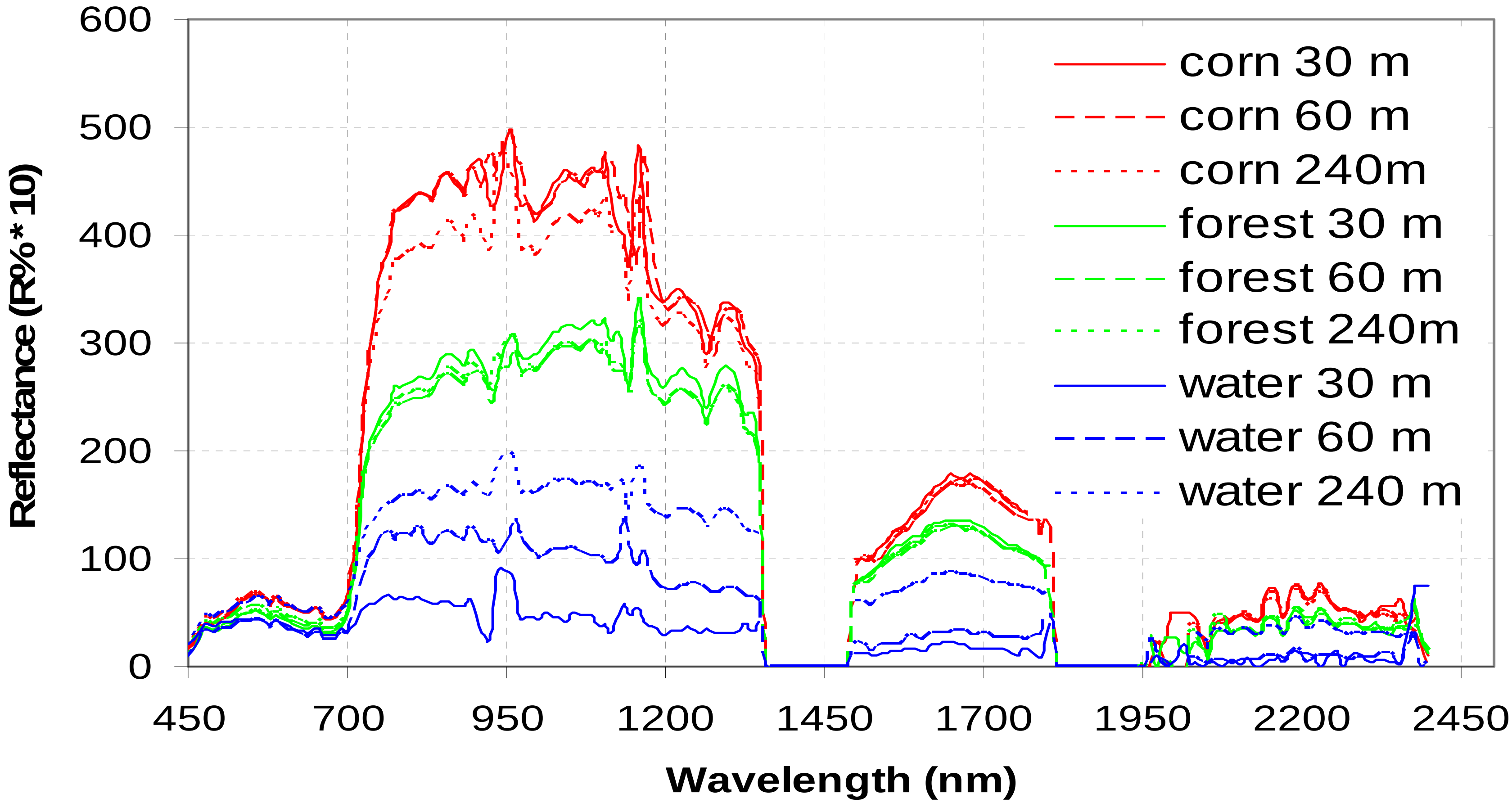
Subset of the mid summer radiance image, used in the aggregations to a larger pixel size (from 30 to 60, 90 and 240 m).

Seasonal Dynamics in VIs for Major Land Cover Types
Greenbelt, MD

Cover Type	Hyperion, 2008	V1	PRI	REIP	Dmax	WBI	Albedo
Corn	13-Jun	1.03	-0.04	712	0.36	0.96	0.461
	18-Aug	1.81	-0.06	722	0.75	1.09	0.197
	3-Oct	1.15	0.04	721	0.51	0.98	0.155
Forest	13-Jun	1.12	-0.06	712	0.89	1.00	0.257
	18-Aug	1.56	-0.03	722	0.51	1.01	0.140
	3-Oct	1.61	-0.10	712	0.42	0.94	0.127
Water	13-Jun	0.15	0.01	712	0.16	1.23	0.058
	18-Aug	0.52	0.02	712	0.10	1.46	0.031
	3-Oct	0.62	-0.07	712	0.08	0.93	0.036

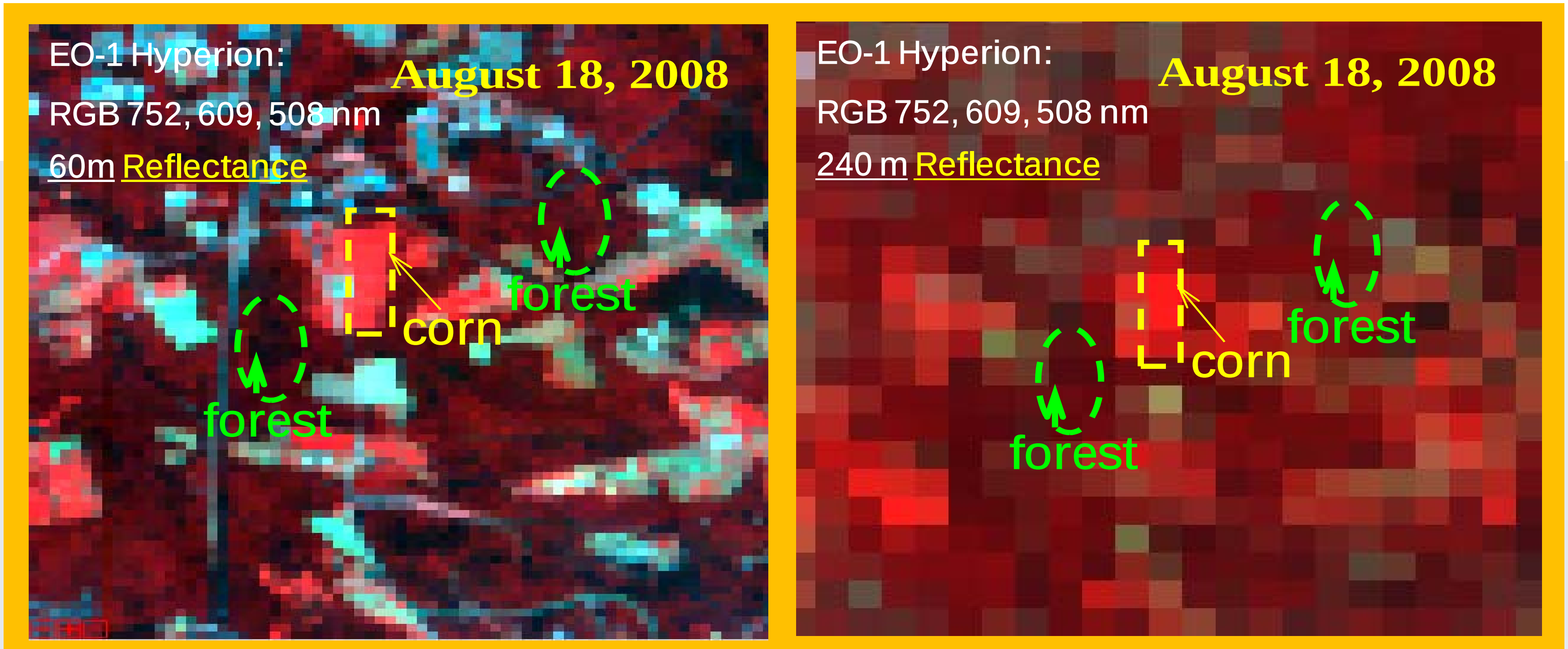
Reflectance Characteristics of Major Cover Types at 30 and 60 m pixel size





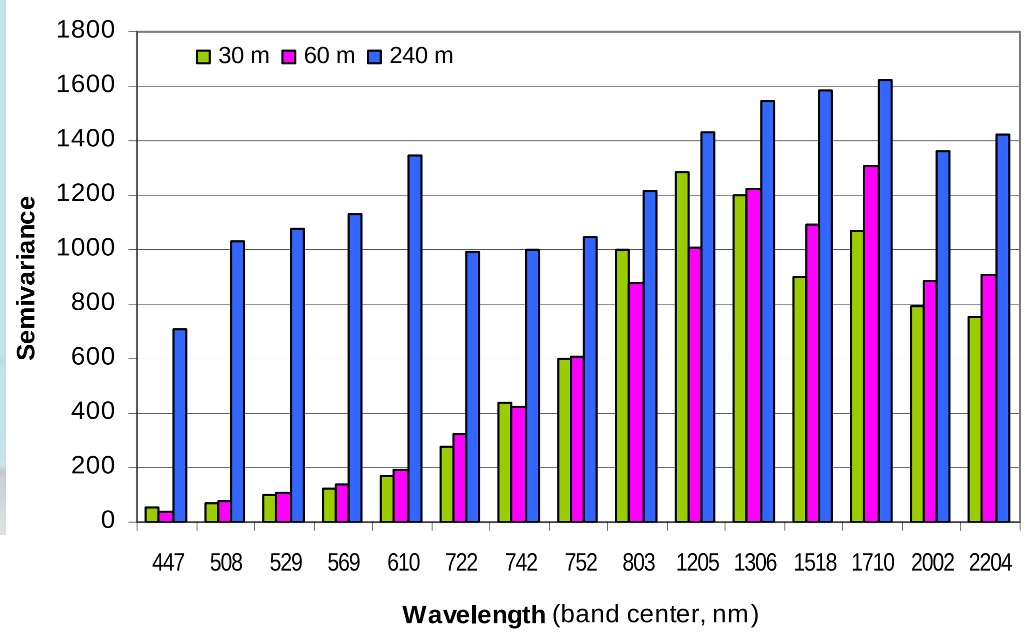
Pixel size	Vegetation Indices for Corn*						Albedo		
	V1	PRI	REIP	Dmax	WBI	NDVI	water	corn	forest
30 m	1.81a	-0.056a	721a	0.75a	1.09a	0.81a	0.03a	0.20a	0.14a
60 m	1.84a	-0.051a	721a	0.74a	1.08a	0.81a	0.05a	0.19a	0.13a
240 m	1.71b	-0.040b	721a	0.67a	1.00a	0.79a	0.09a	0.18a	0.13a

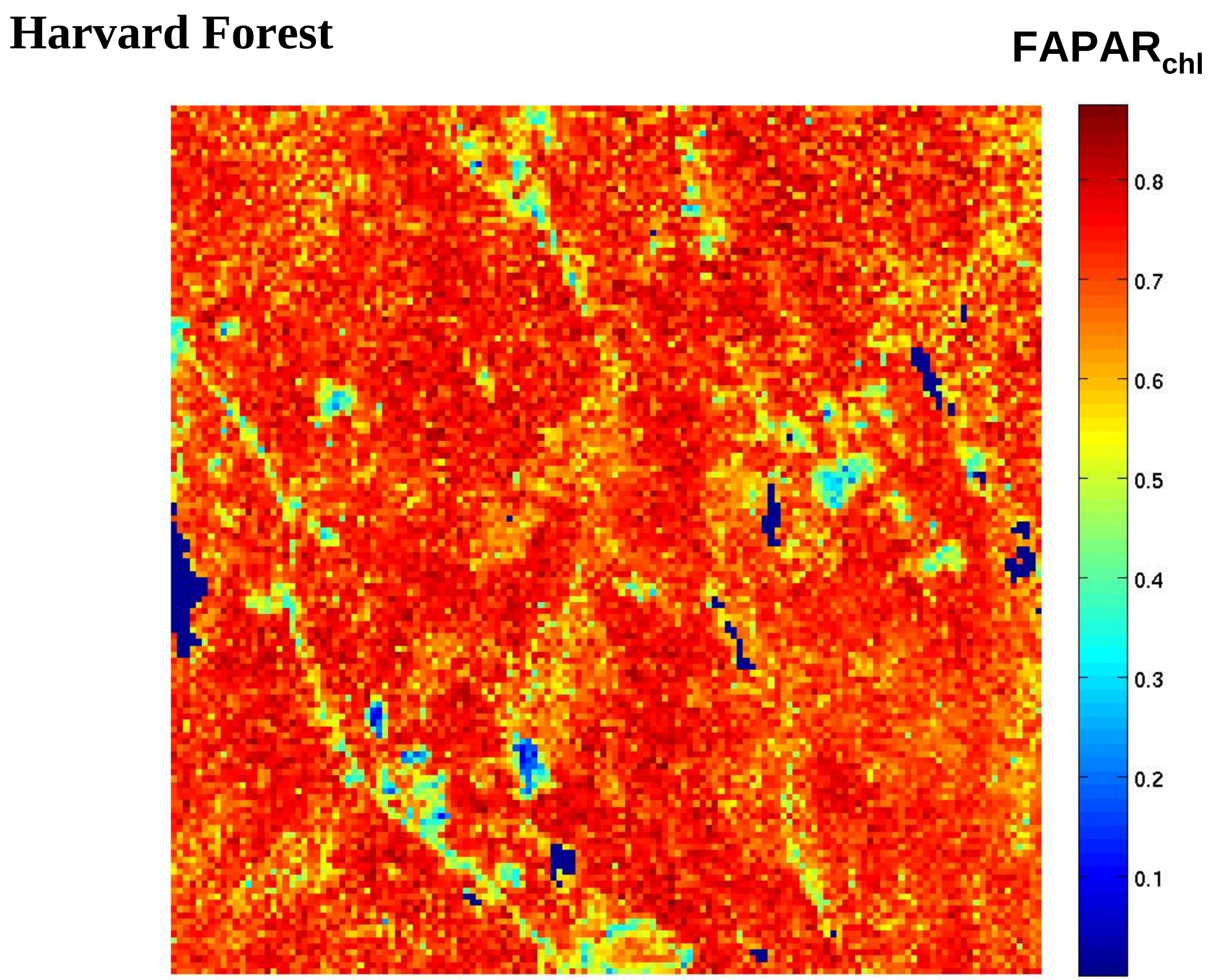
* different letters indicate statistically significant differences



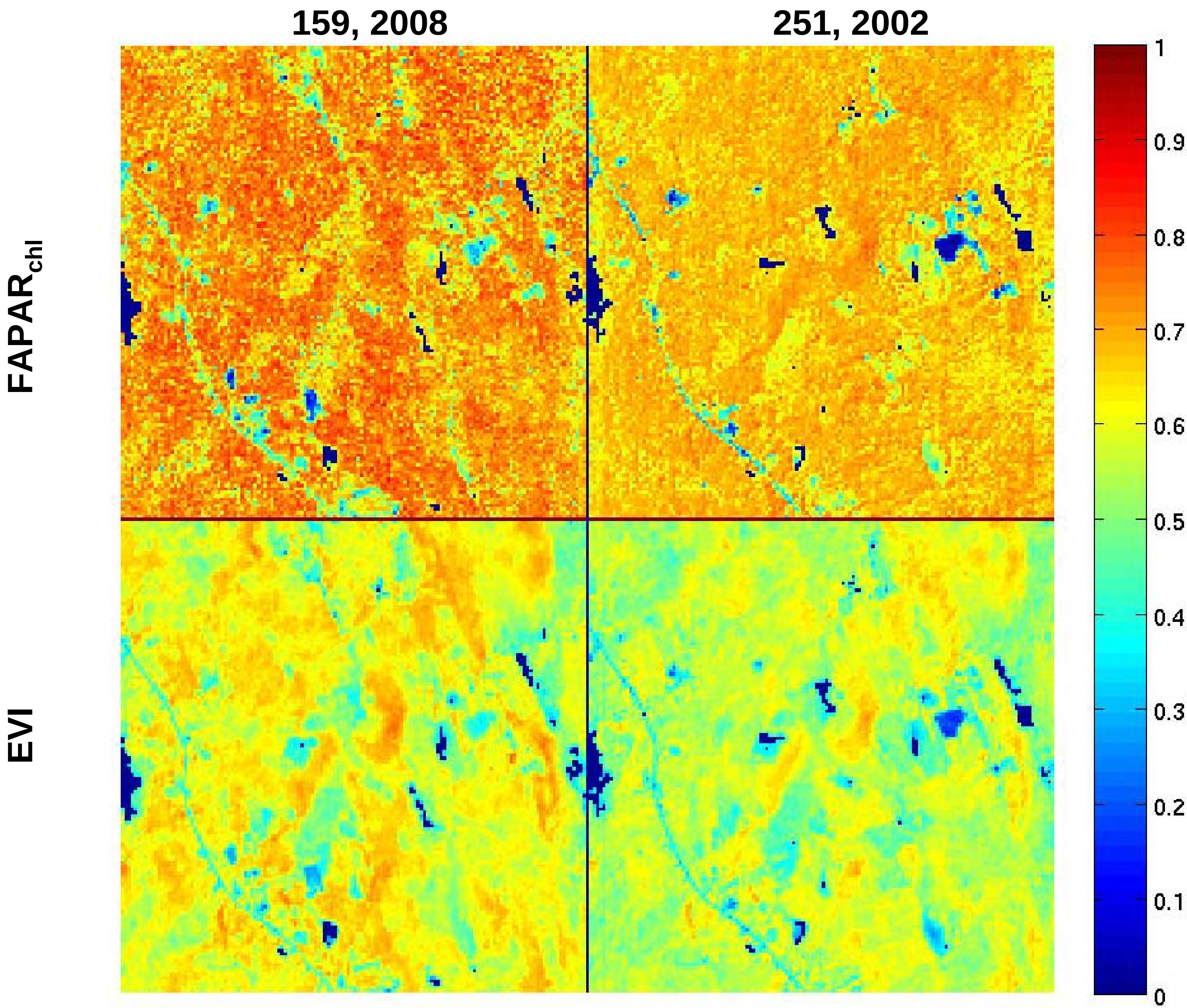
EO-1 Hyperion image acquired in August 18, 2008 aggregated to 60 & 240 m pixels

The Global Semivariance *(describes the* *spatial autocorrelation* *within a spectral band)* **is quite similar for 30 m and 60 m pixels, and significantly different for the 240 m.**





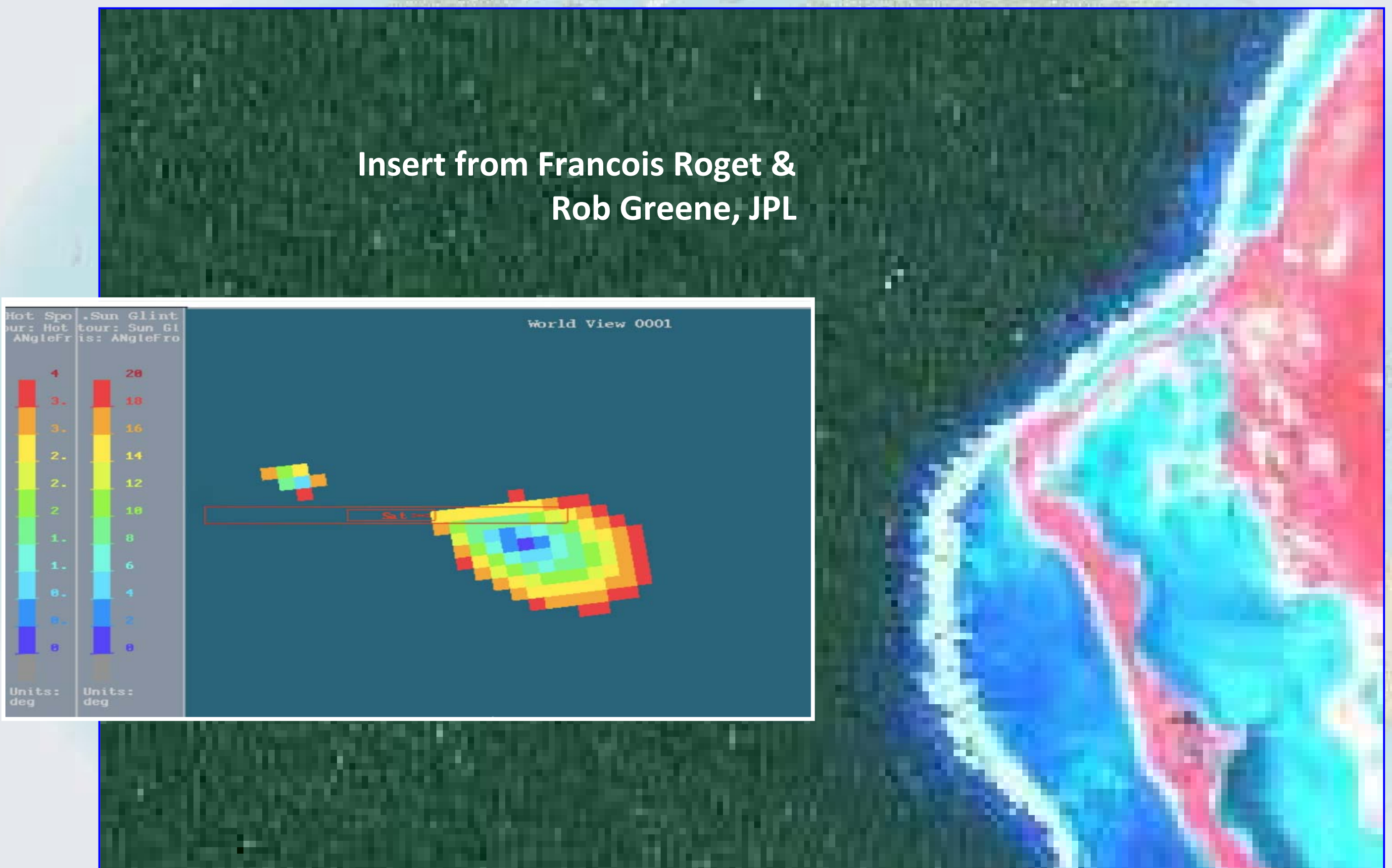
$FAPAR_{chl}$ image extracted from atmospherically corrected EO-1 Hyperion data for the Harvard Forest area on DOY 159, 2008 (water bodies are set to be 0)



159, 2008
251, 2002
FAPARchl
EVI
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

EO-1 support of HyspIRI

Sun glint off coast of Belize and BRDF effects

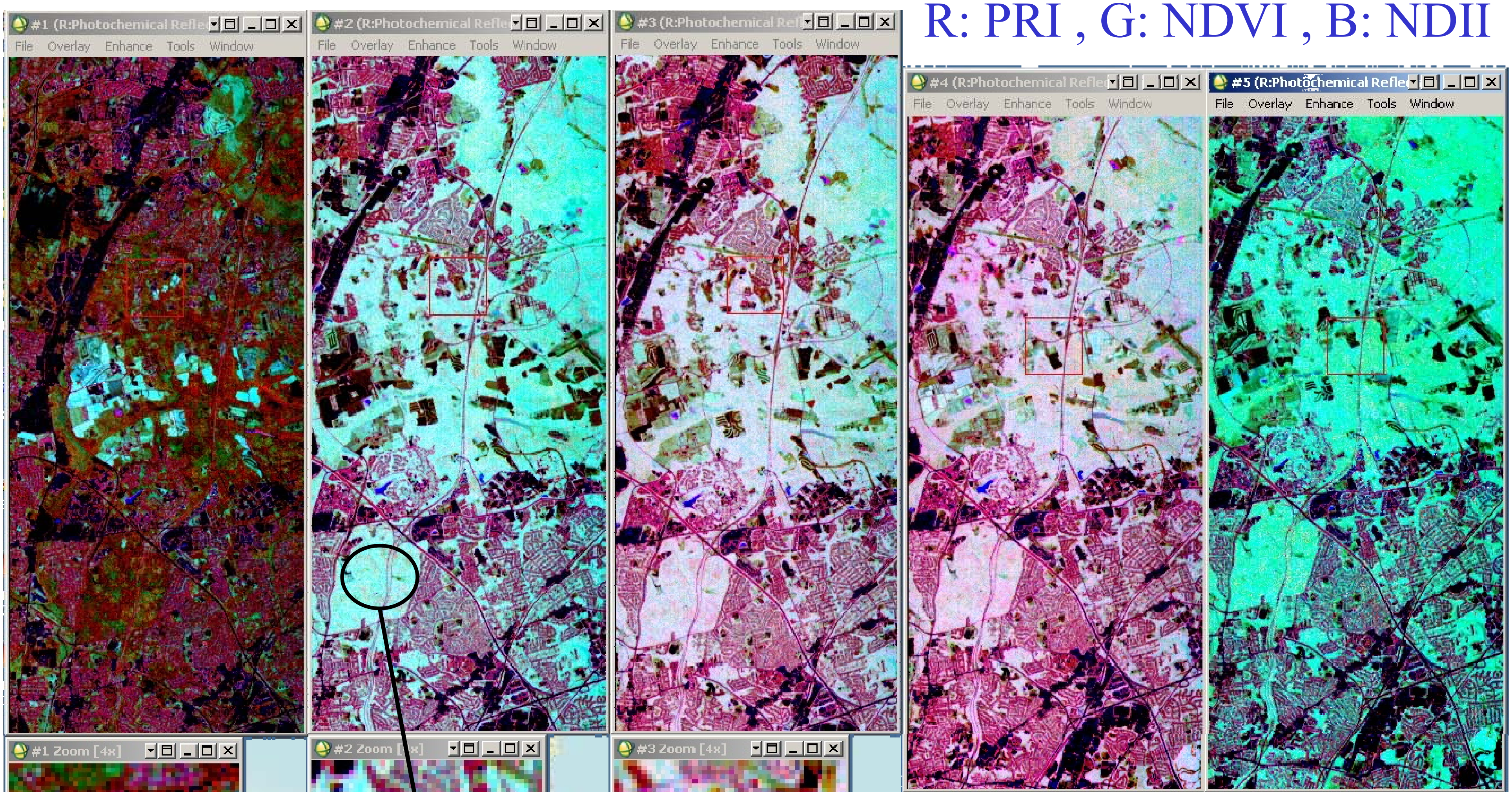


Color composites using Hyperion VIs

Beltsville area in 2008

- Exploring the potential of using Hyperion VIs for terrestrial ecology studies
- R: PRI ; G: NDVI ; B: NDII
- Non-vegetated area showed steady pattern through the season
  - Implication: steady reflectance values
- Phenological cycle: green-up (April-June) and senescence (August-October) were observed.
- During senescence, NDII (water) dropped faster than NDVI (greenness)
- The table shows VI values (top to bottom: PRI, NDVI, NDII) in the Greenbelt Park area (circle on images)

R: PRI , G: NDVI , B: NDII



April 18	June 21	July 8	August 18	October 3
-0.002	-0.049	-0.016	-0.010	-0.095
0.4	0.82	0.78	0.80	.076
0.11	0.37	0.35	0.34	0.21

Comparisons between *in situ* and Hyperion observations

USDA Cornfield in Beltsville, MD in 2008

In situ	Hyperion	VIs	OOptics	Sim_HYP	HYP
August 19	August 18	PRI	-0.03	-0.026	-0.04
		NDVI		0.75	0.80
October 2	October 3	PRI	-0.04	-0.05	-0.08
		NDVI		0.66	0.70

OOptics: values derived from Ocean Optics measurements (~1.5 nm FWHM)

Sim_HYP: values derived from simulated Hyperion bands (~ 10 nm FWHM) using Ocean Optics measurements

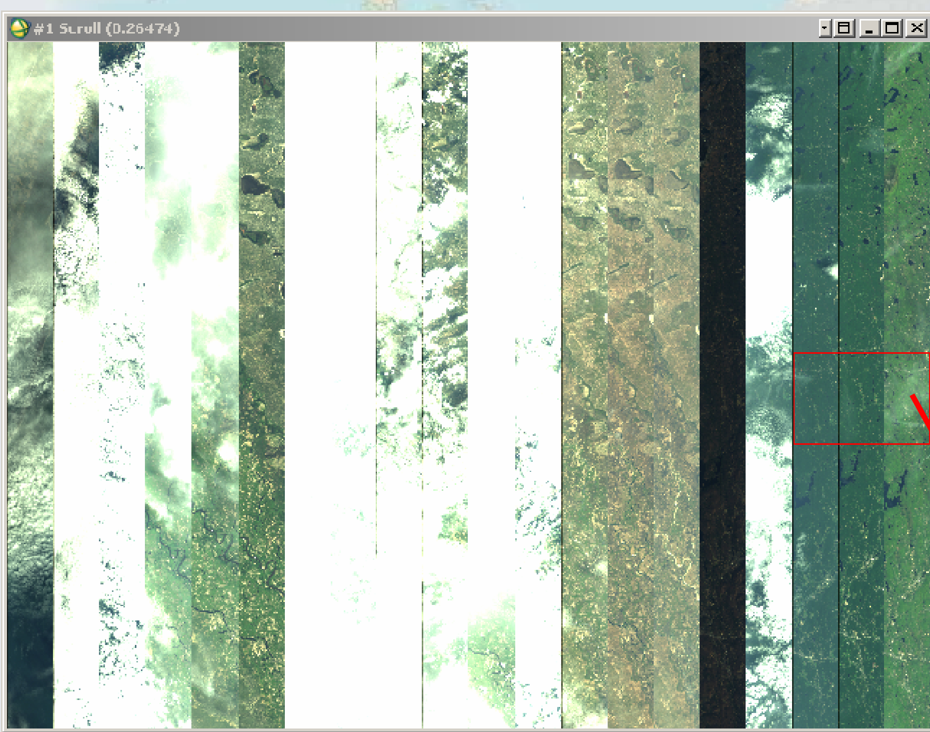
HYP: values derived directly from EO-1 Hyperion imagery

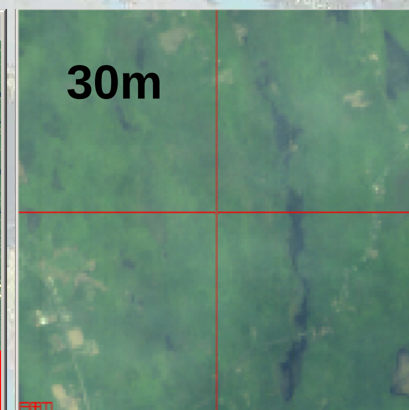
Automated Tools and Applications

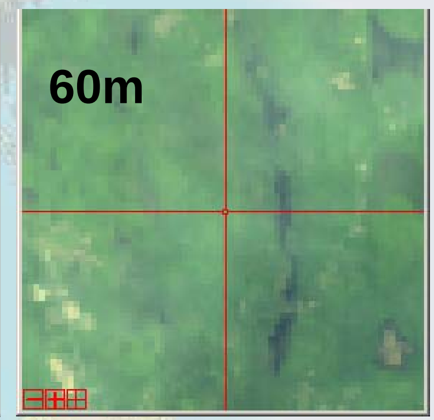
HyspIRI simulation using Hyperion data

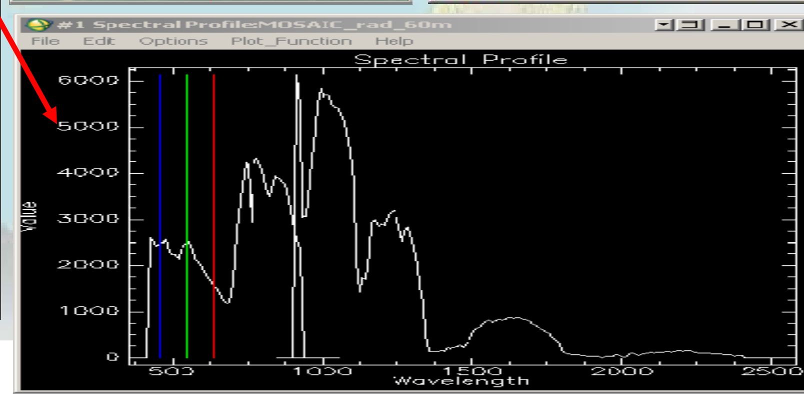
Goals: To test a) data streaming & b) data compression

- 20 random Hyperion L1R scenes were stitched together to match HyspIRI swath
- At 30m and 60m spatial resolution









Earth Observing 1 (EO-1) Campaign Manager on-line Tool

NorthCal Fires	Northern California Fires	fire	patrice	Yosemite Telegraph Fire, Basin Complex, Whiskeytown Complex, ...	06/29/2008 02:13 PM	06/29/2008 09:18 PM	0.4	Edit Delete Show
NSP	Nationa Signature Program	intel	patrice	TA-03, TA-02, TA-01	03/03/2008 10:25 AM	05/16/2008 12:42 PM	0.2	Edit Delete Show
Oceans Innovation	Oceans Innovation Workshop Demo	algae	patrice	Monterey Bay	09/10/2008 06:18 PM	09/16/2008 06:38 PM	1.0	Edit Delete Show
Salt Marshes	To determine salinity contents of flooded areas	flooding	patrice	Lancaster, VA	07/26/2008 02:36 PM	07/26/2008 02:36 PM	-	Edit Delete Show
SoCal Fires	Southern California Fires	fire	patrice	-	09/06/2007 12:00 AM	06/28/2008 09:23 PM	0.0	Edit Delete Show
UAV	NASA Ames Ihkana flight scenario	fire	veri_pat	Flood	09/06/2007 12:00 AM	06/04/2008 02:00 PM	0.0	Edit Delete Show
UAV 2	NASA Ames Ihkana Flight Scenario	fire	scott	UAV 2 Test	09/17/2008 12:40 AM	09/17/2008 12:40 AM	-	Edit Delete Show
UAV 3	-	fire	UNKNOWN	California	09/18/2008 03:53 PM	09/18/2008 03:53 PM	-	Edit Delete Show

http://geobpms.geobliki.com/

Scenario/Campaign Tasking Requests for UAV 3

Search Create New

Title	Content	Geolocation	Scenario Feasibilities

Tasking Request:

Title:	California
Description:	
Category:	
Latitude:	41.3
Longitude:	-123.8
Country Code:	US
Country Name:	United States
Zone Number:	36
Zone Name:	Northern California
Region Number:	3
Region Name:	Oregon, California and Nevada
Admin Code:	CA
Admin Name:	California
Nearby:	Notchko, Surgone, Shregegon (historical), Mettah, Pekwan (historical), Pecwan, Johnsons, Waseck, Wright Place, Martins Ferry (historical)
Created At:	Fri, 19 Sep 2008 02:32:22 -0000
Updated At:	2008-09-19
	Show Map
Feasibilities	

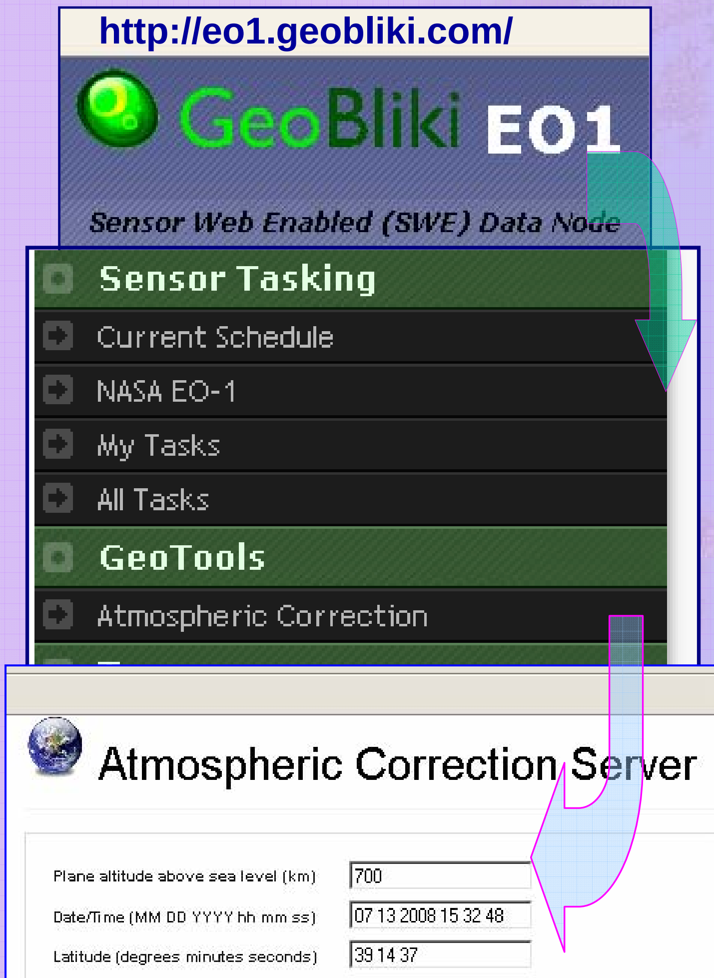
1 Found

USAFRICOM	USAFRICOM Testing	flooding	cappelaere	Zimbabwe	06/19/2008 02:58 PM	06/19/2008 02:58 PM	-	Edit Delete Show

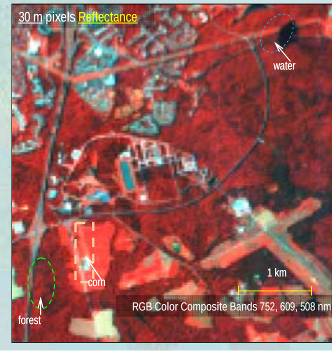
EO-1 L2 Tools and Prototype Reflectance Products

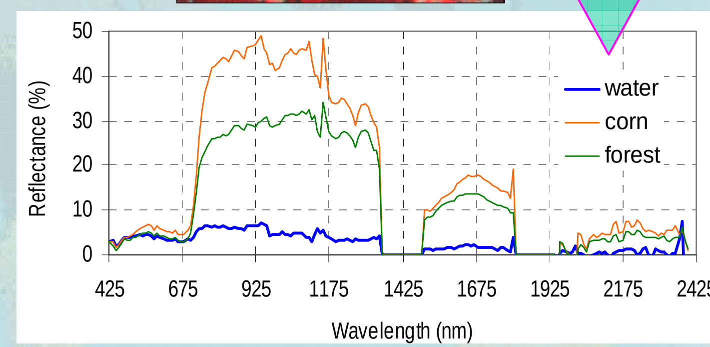
albedo; fAPAR; LAI; spectrum derivatives; chlorophyll, N, water content …

EO-1 Toolkit



EO-1 Product Prototypes



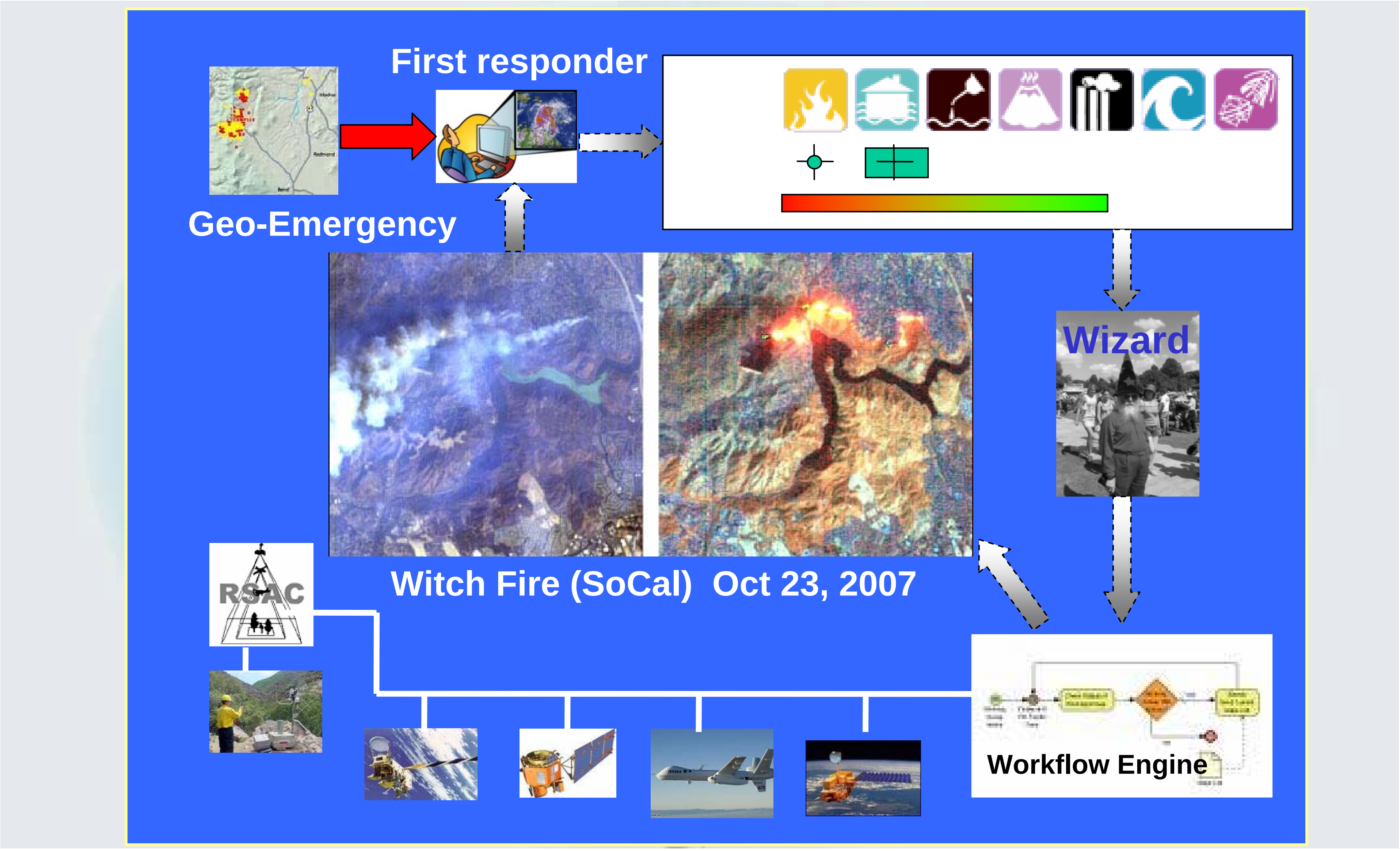


Pixel size	Vegetation Indices: VI	PRI	REIP	Dmax	NDWI	NDVI	Albedo water	corn	forest
30 m	1.81	-0.14	721	0.749	0.14	0.81	0.03	0.20	0.14
60 m	1.88	-0.15	721	0.748	0.15	0.82	0.04	0.20	0.13

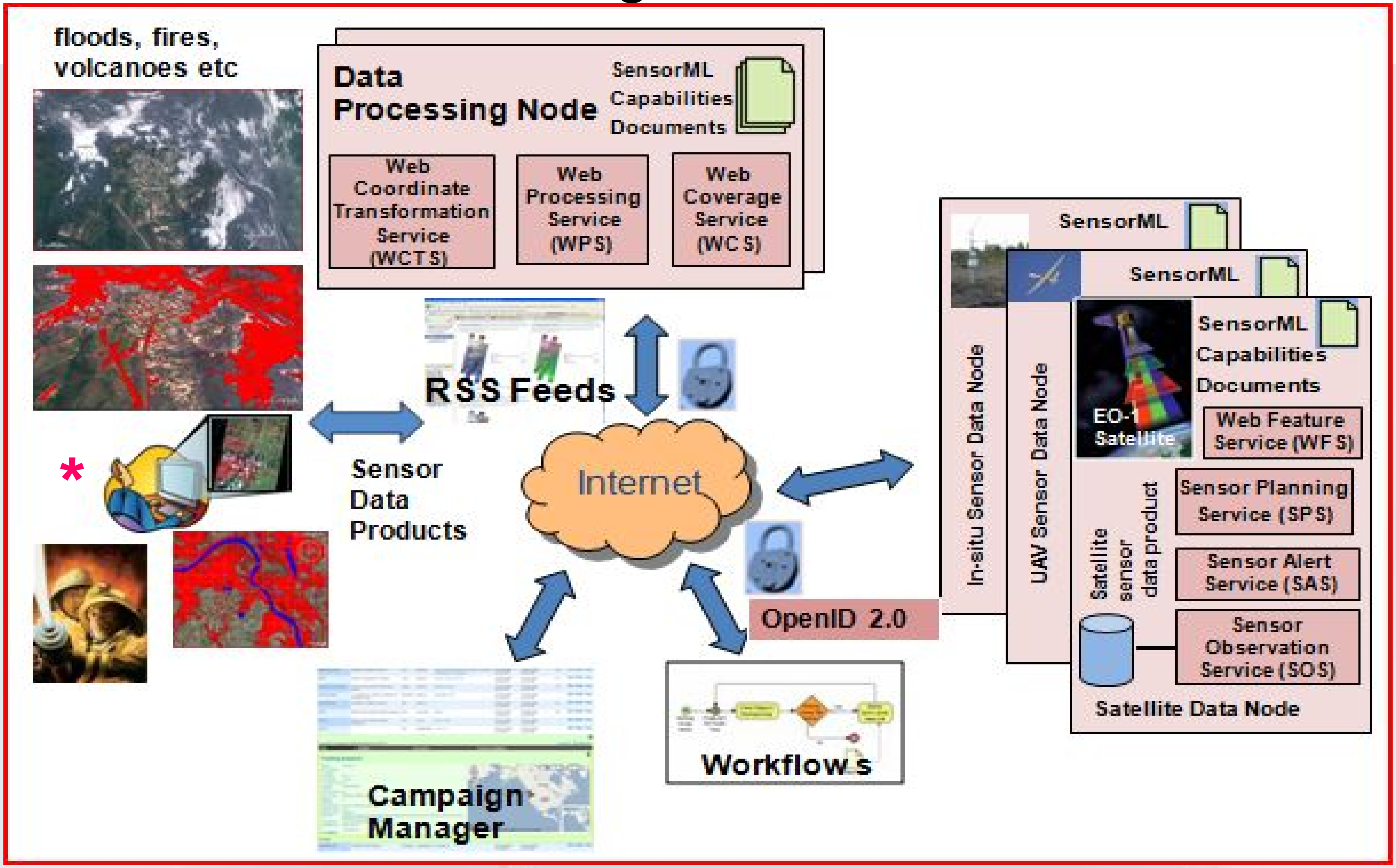
Goals: To enable the conventional users to apply corrections and develop products and applications

.

EO-1 serves as a Pathfinder for SensorWebs and Enabling of Rapid Response Remote Sensing



SensorWeb High Level Architecture



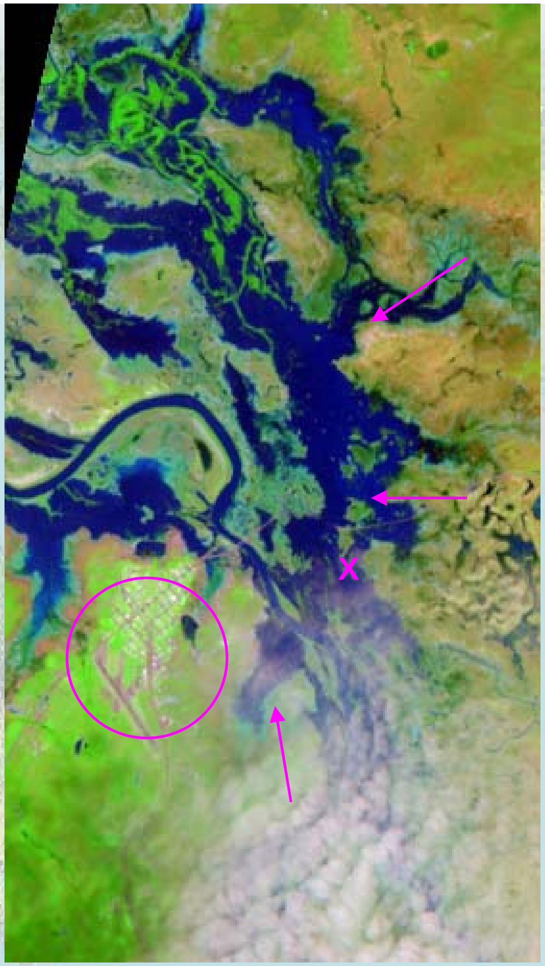
The SensorWeb architecture was developed on EO-1 as a pathfinder effort to encapsulate sensors and data processing algorithms with Open Geospatial Consortium standardized Web 2.0 Service interfaces. Thus future missions, especially HyspIRI, will be able to significantly lower the cost of interoperating, automating procedures and enable rapid customization of data products.

Disaster Monitoring/Sensor Webs

<u>Disasters:</u> ALI Imagery of Australian Flood (March 2009)

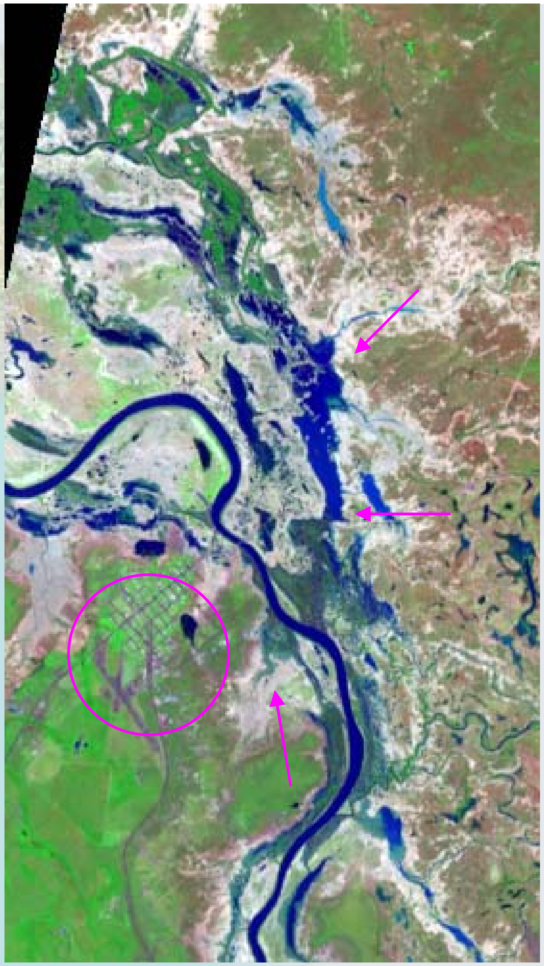
March 12, 2009
True-Color Image
EO-1 ALI Image

In this true-color image, note how the water color is so muddy that it makes discerning the extent of the flooding difficult



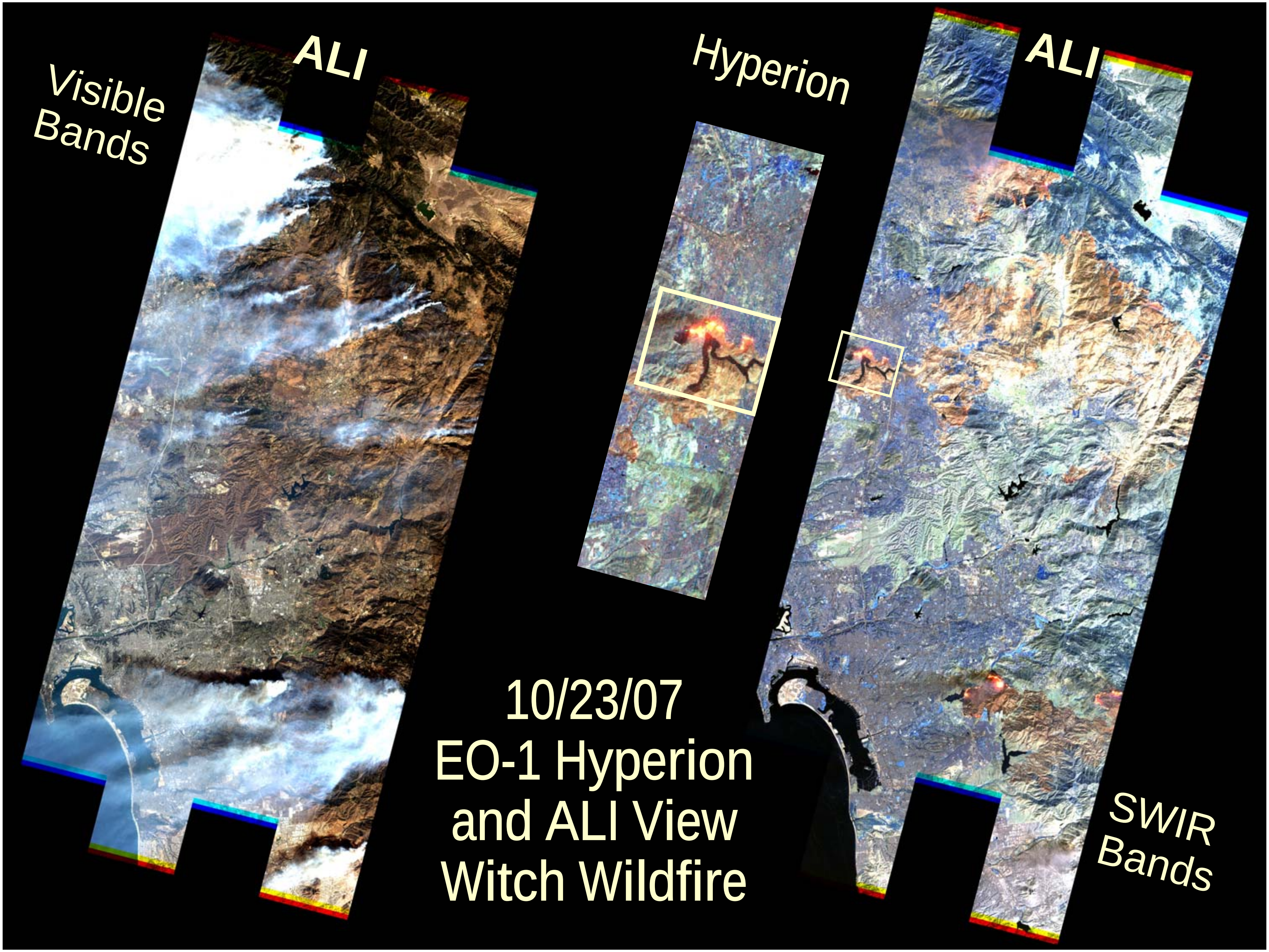
March 12, 2009
False-Color Image
EO-1 ALI Flood Product

This false-color image combines infrared and visible light, which makes the extent of the flooding far more obvious. Water is dark blue, while plant-covered land is green, and bare earth is rosy tan.



March 25, 2009
False-Color Image
EO-1 ALI Flood Product

Two weeks later, the flood waters have receded even more, which the EO-1 Flood Product makes evident.


Visible Bands
ALI
Hyperion
ALI
10/23/07
EO-1 Hyperion and ALI View Witch Wildfire
SWIR Bands

Disasters: EO-1 ALI images of New Orleans after Hurricane Katrina

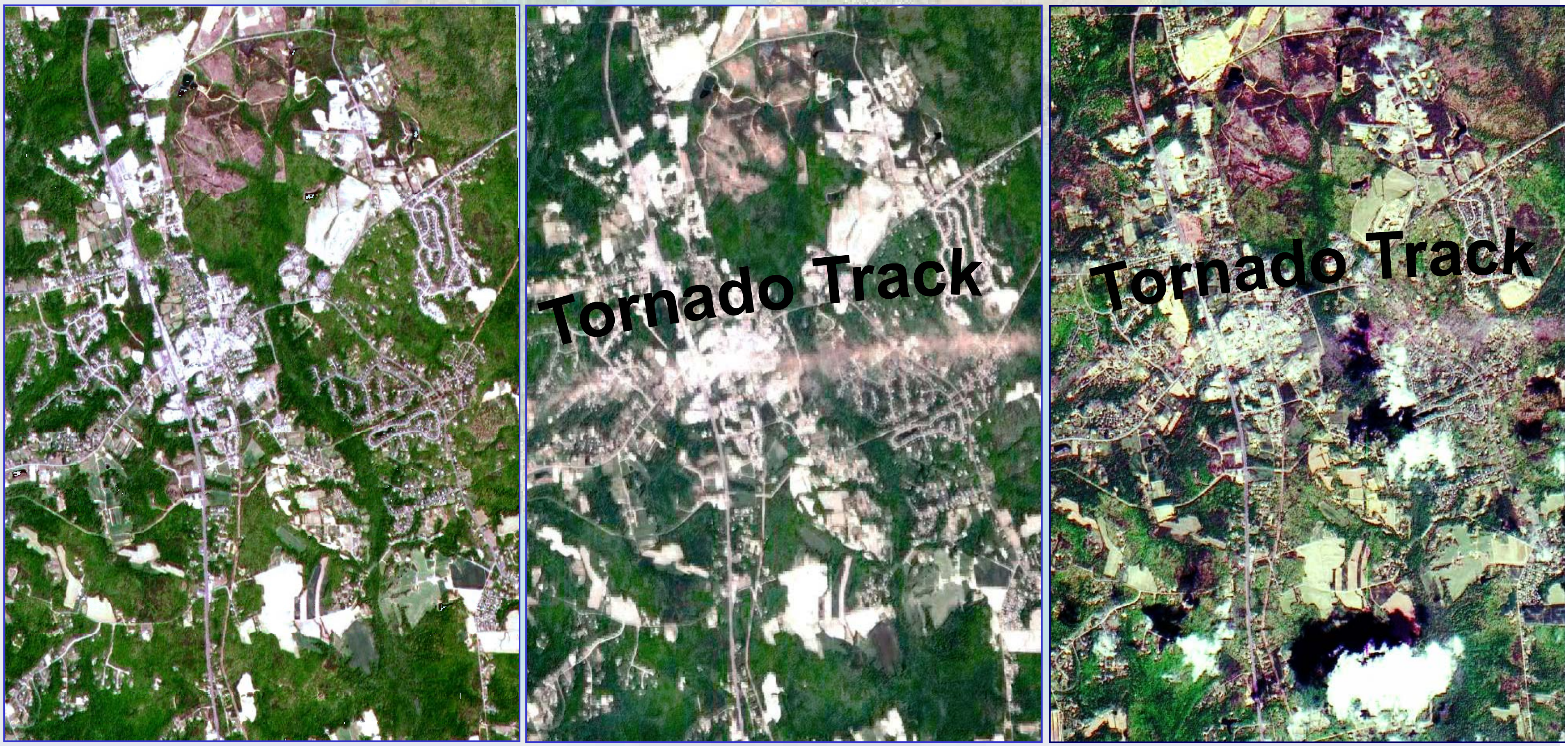
ALI pan-sharpened images acquired just two days apart, clearly showing the receding flood waters from Hurricane Katrina.

Ungar (2005)

<u>Disasters:</u> La Plata, MD Tornado after-effects still visible one year later

EO-1 ALI Pan-sharpened images (Ungar, 2003)

April 24, 2002 | May 1, 2002 | April 27, 2003



Instrument Characteristics and Data Availability can be found at the following URLs

AVIRIS: http://aviris.jpl.nasa.gov/

MASTER: http://masterweb.jpl.nasa.gov/

Hyperion: http://eo1.gsfc.nasa.gov/ and http://eo1.usgs.gov/

ASTER: http://asterweb.jpl.nasa.gov/

Recent ER-2 flights carrying both AVIRIS and MASTER

Flight	Date	Area	Flight	Date	Area
01-115	10 Aug 2001	Vancouver Island, Canada/Hoquiam, WA	02-914	02 Nov 2001	Big Island/Maui/Molokai, HI
01-123	01 Aug 2001	Mono Lake/Lake Tahoe, CA	02-915	04 Nov 2001	Big Island/Oahu/Maui, HI
01-124	17 Aug 2001	Death Valley/Mono Lake/Walker Lake, CA & NV	02-916	05 Nov 2001	Big Island/Oahu, HI
01-125	18 Aug 2001	Mono Lake/Fort Irwin/Pinto Basin, CA & NV	02-917	06 Nov 2001	Big Island/Oahu, HI
02-602	02 Oct 2001	Santa Monica/Santa Barbara, CA	02-918	07 Nov 2001	Ferry Honolulu, HI to Dryden, CA
02-902	14 Oct 2001	Lake Tahoe/Mono Lake, CA	04-601	03 Oct 2003	Ivanpah, CA & NV
02-903	15 Oct 2001	Ferry to Hawaii from Dryden, CA	06-626	19 Sep 2006	Sheely Farm/Mono Lake, CA
02-904	16 Oct 2001	Big Island of Hawaii	06-627	20 Sep 2006	Cuprite, NV
02-905	19 Oct 2001	Big Island/Maui/Molokai, HI	06-628	22 Sep 2006	Jasper Ridge/Monterey Bay, CA
02-906	20 Oct 2001	Big Island of Hawaii	06-629	25 Sep 2006	Yellowstone National Park, WY, MT, & ID
02-908	24 Oct 2001	Big Island/Kahoolawe, HI	06-630	26 Sep 2006	Mono Lake/Lake Tahoe, CA
02-909	25 Oct 2001	French Frigate Shoals, HI	06-631	27 Sep 2006	Tonkin, NV
02-910	26 Oct 2001	Big Island/Maui/Kauai, HI	07-601	02 Oct 2006	Minnesota/Wisconsin
02-911	29 Oct 2001	Big Island/Molokai/Kauai, HI	08-627	11 Jun 2008	Jasper Ridge/Moffett/Santa Monica/Big Sur Fire, CA
02-912	30 Oct 2001	Kahoolawe/Big Island, HI	08-629	19 Jun 2008	Coal Oil Point, CA

NASA/ROSES A.29: HyspIRI preparatory activities using existing imagery

EO-1 Data

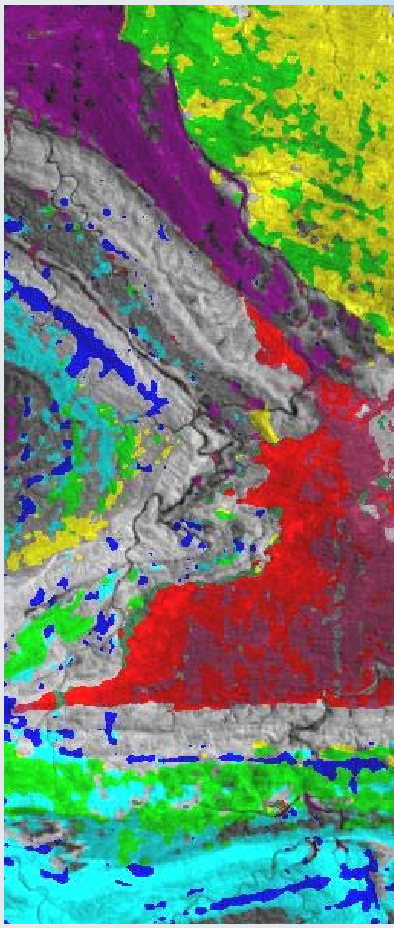
- Hyperion and ALI archived and newly acquired data are now provided as L1G at no cost by EROS/USGS
- Hyperion L1R archived data can be obtained by special request through the GSFC MSO
- New data acquisition requests are funneled through EROS/USGS

Application Examples

Hyperion Maps Mt. Fitton Geology

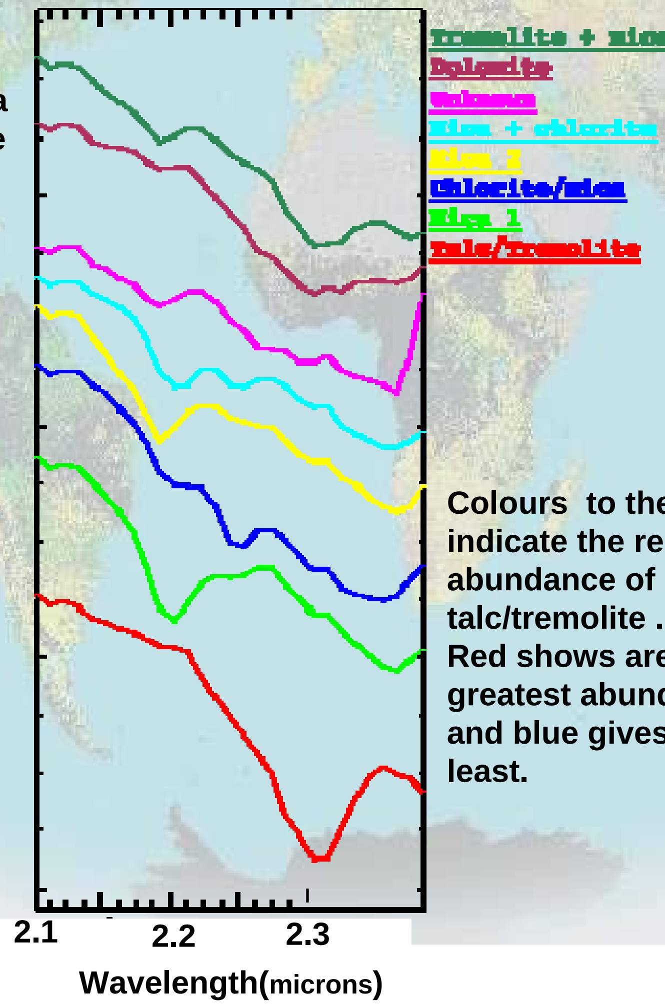
Automatic mineral mapping algorithm creates, in 30 seconds, a quick-look mineral map (left & centre). More precise detail is on right.

Mineral Map



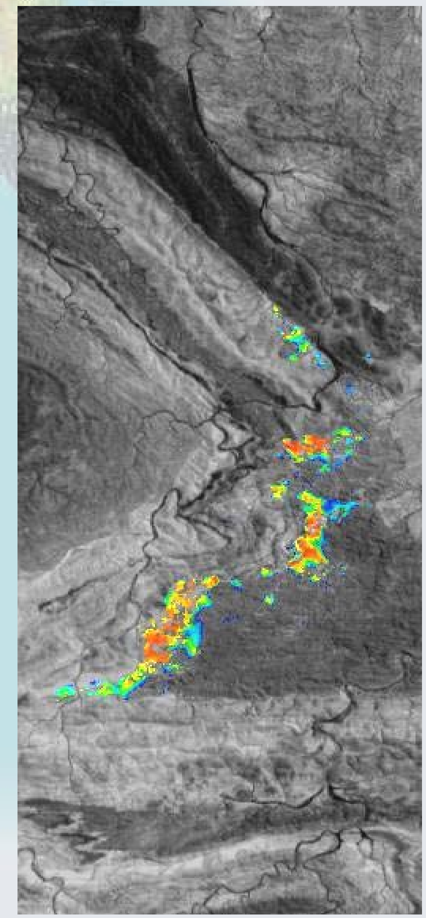
Mineral Spectra

Colours of spectra match the thematic image to left.



Colours 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

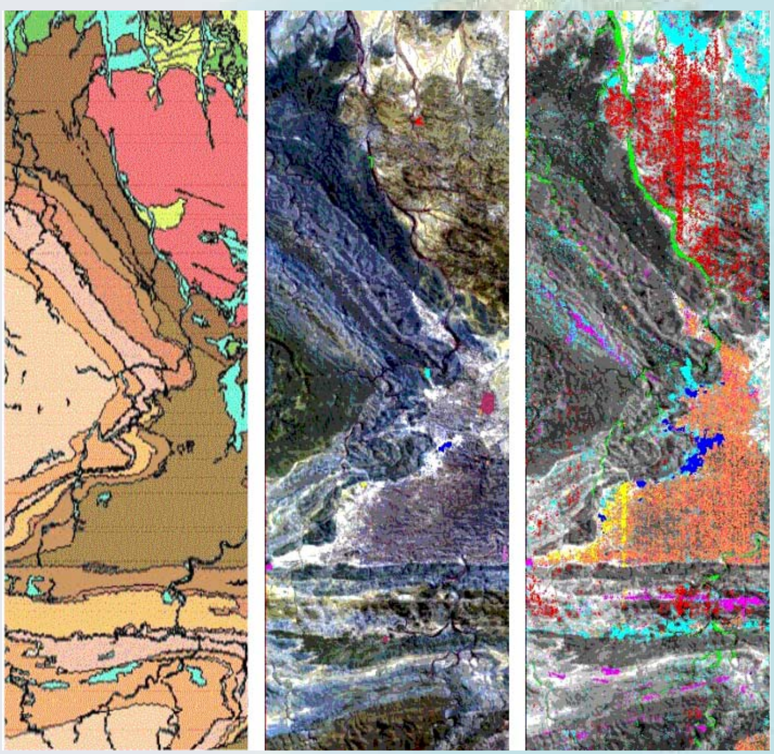


(Courtesy of CSIRO Australia)

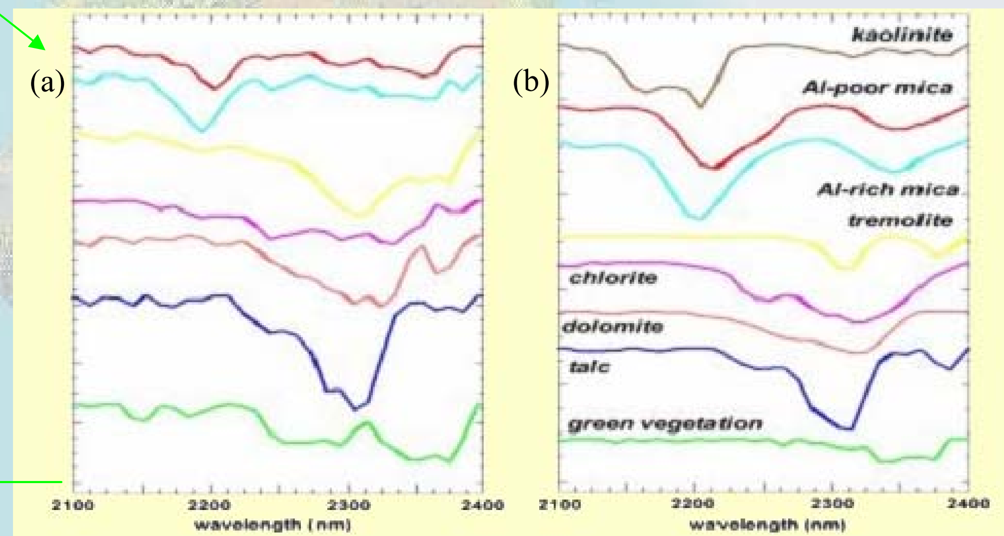
Hyperion Maps Mt. Fitton Geology

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

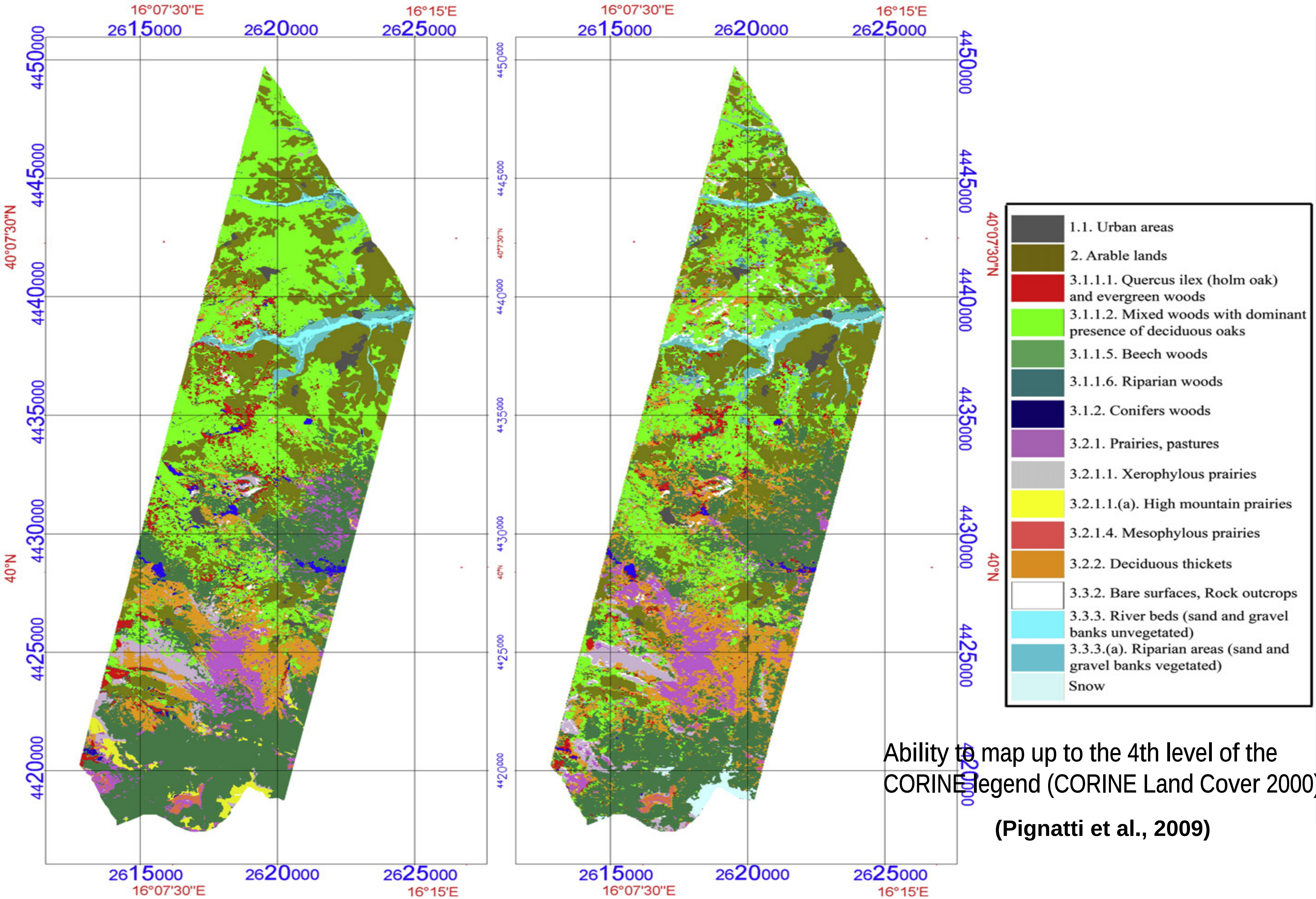
(2) Hyperion three color image (RGB) showing regions of interest

(3) Hyperion surface composition map using SWIR spectra above

Courtesy of CSIRO, Australia

Mapping land cover and vegetation diversity in a fragmented ecosystem

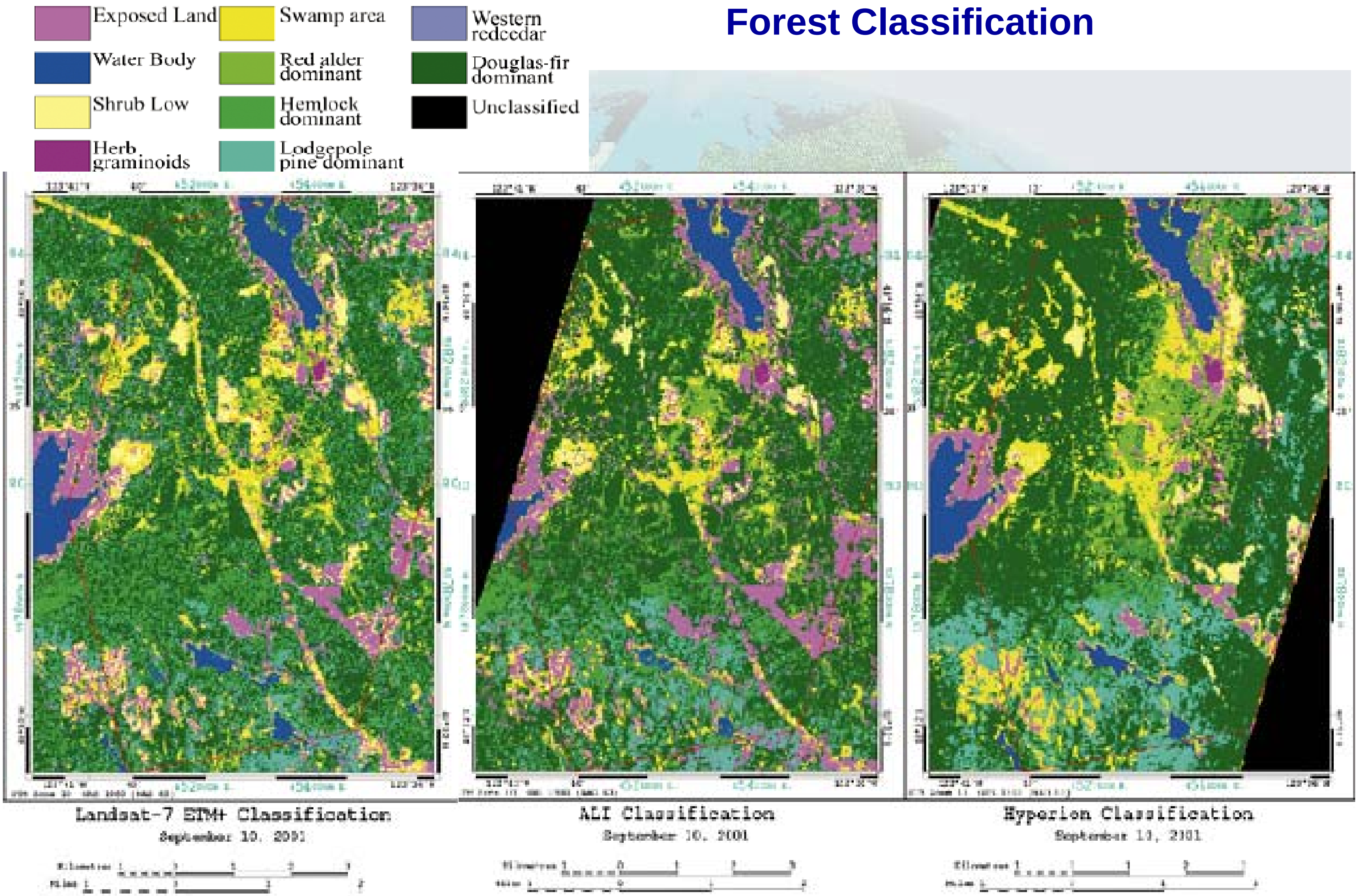
(a) MIVIS — Hyperion (b)



Ability to map up to the 4th level of the CORINE legend (CORINE Land Cover 2000)

(Pignatti et al., 2009)

Evaluation of Hyperion and ALI for Forest Classification

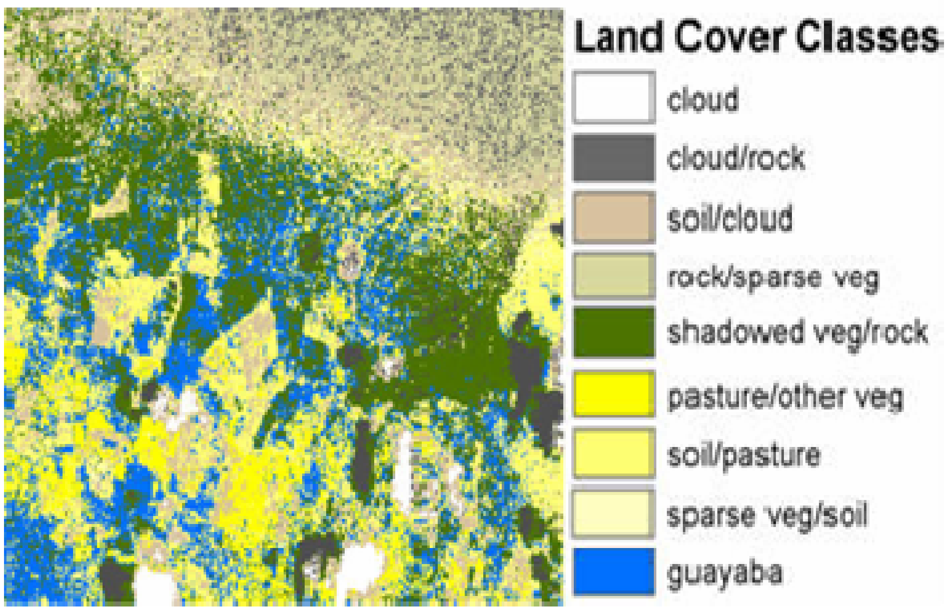


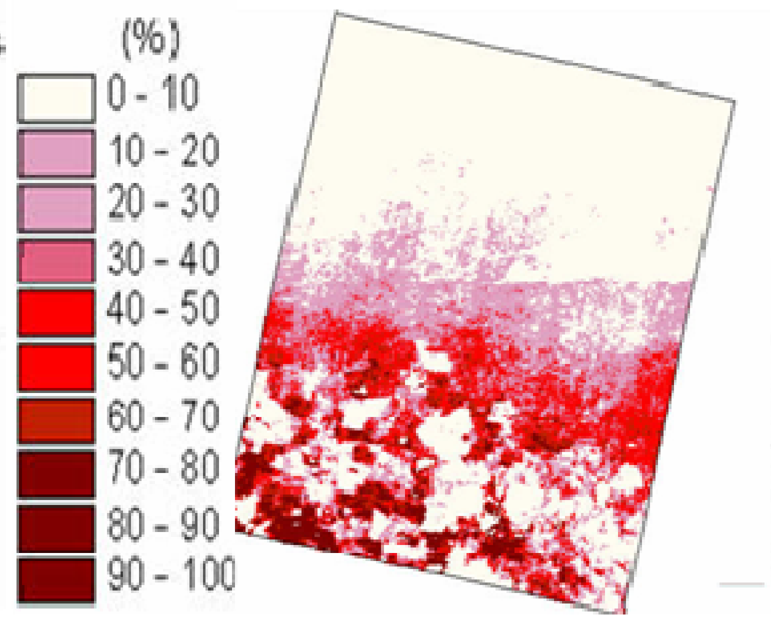
Goodenough *et al. 2003*

Detection of Invasive Plants in the Galapagos National Park and Archipelago, Ecuador by merging Hyperion and *QuickBird*

Classification of guava (blue) and other land cover types

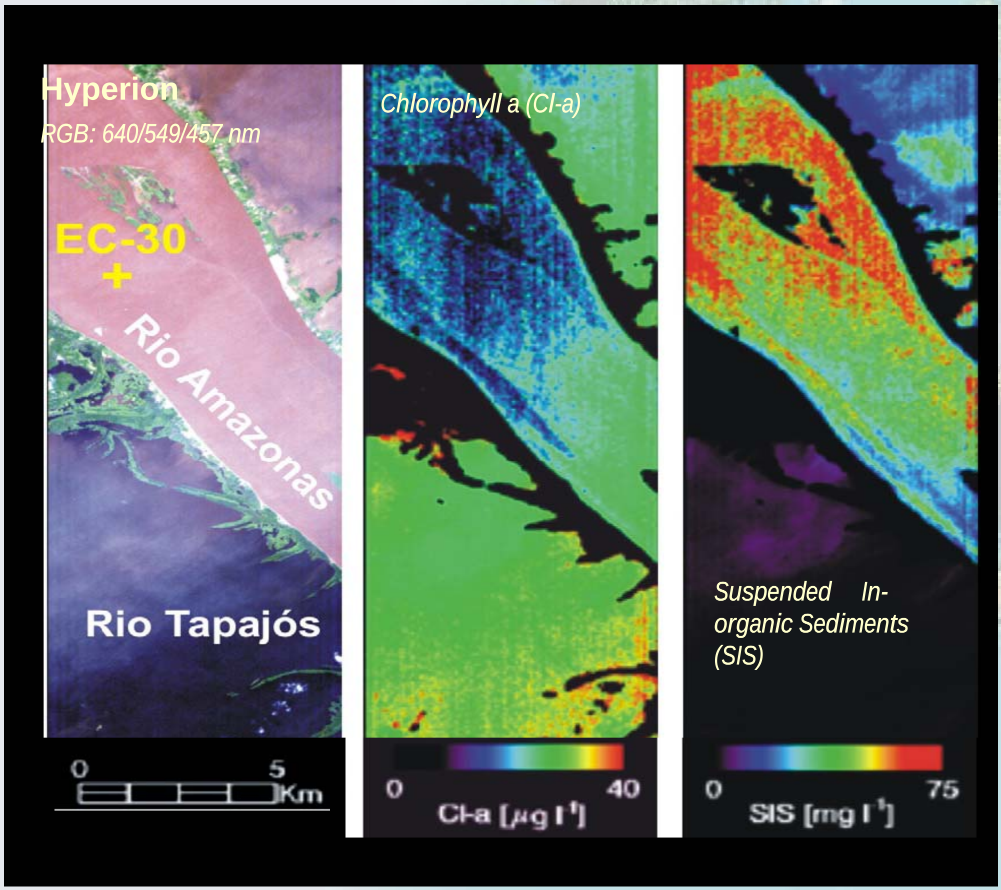
Spectral un-mixing of Hyperion data for the characterization of guava (%)



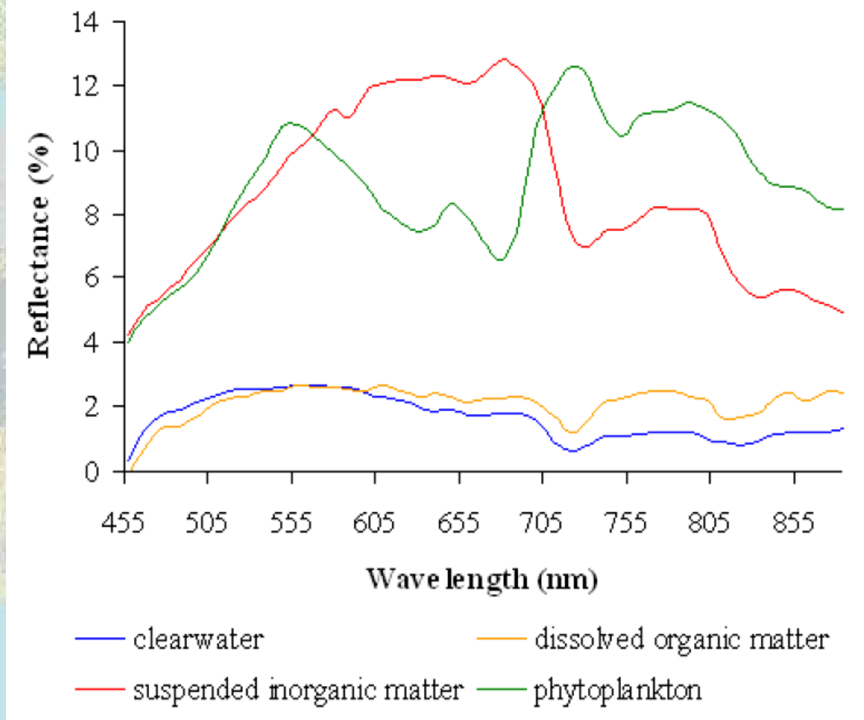


Walsh et al., 2008

Composition of Inland Tropical Amazon Floodplain Waters Using Hyperion Derivative Analysis



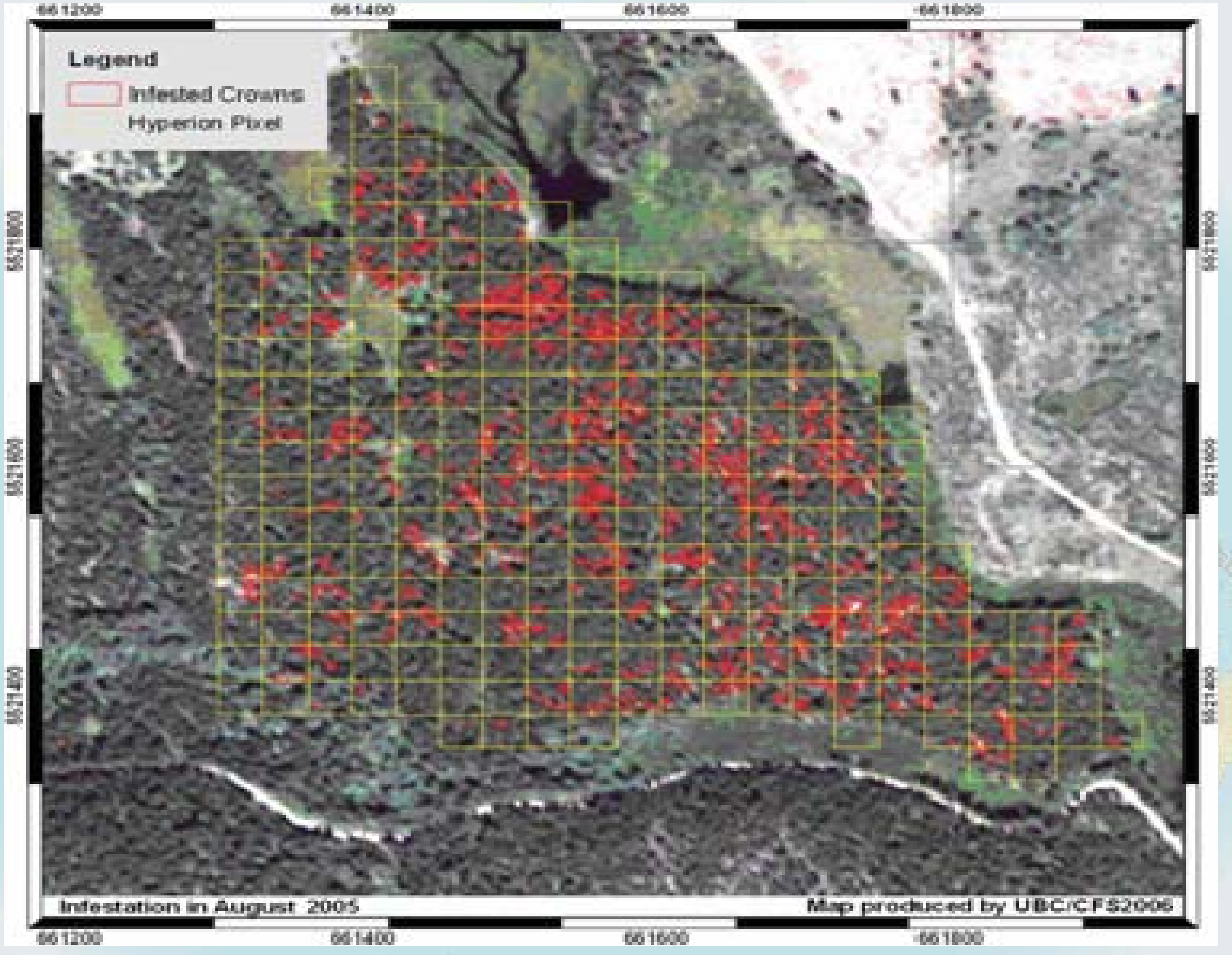
Hyperion end-members spectra of waters dominated by optically active substances



(Rudorff et al., 2007)

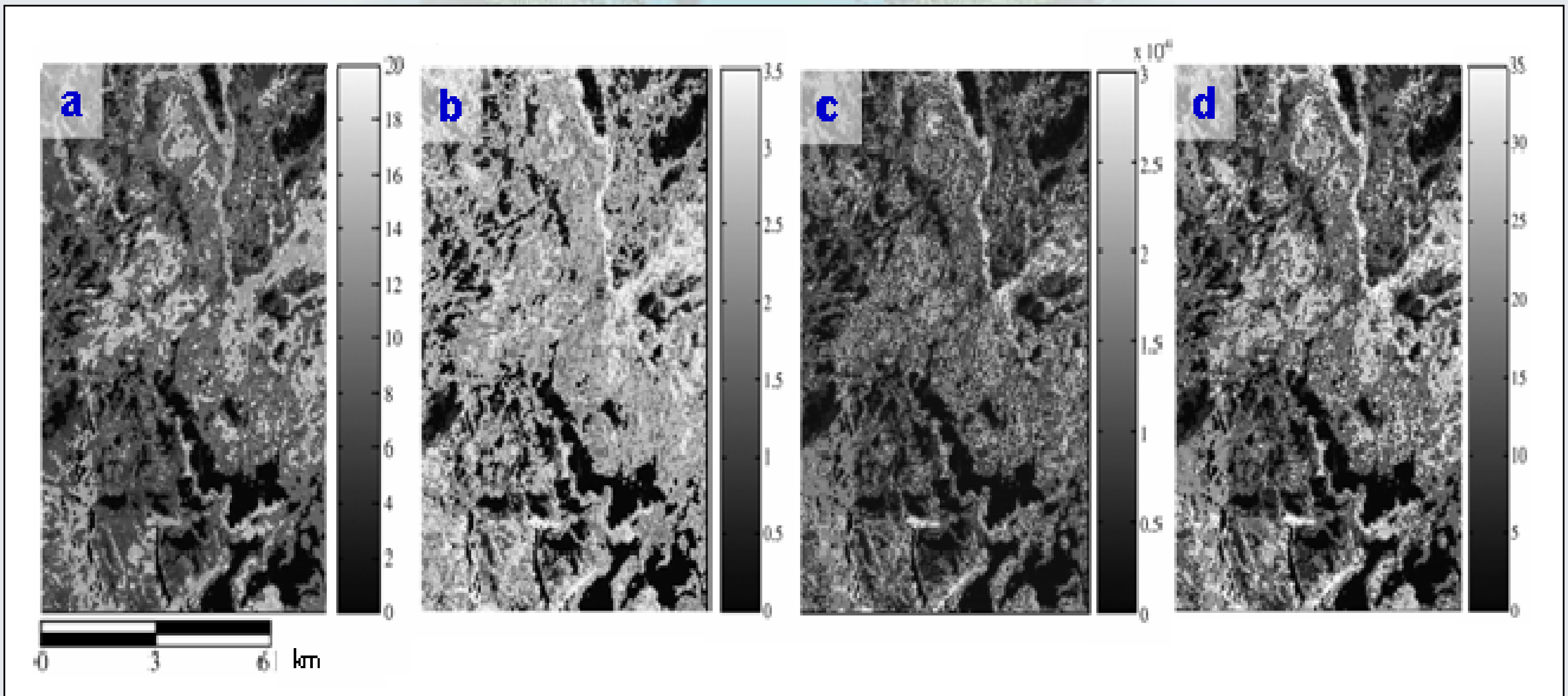
Detection of mountain pine beetle red attack damage, using Hyperion moisture stress indices (MSI)

(White et al. 2007)



Individual tree crowns with mountain pine beetle red attack damage were identified using the Hyperion spectra then overlaid on a QuickBird image and are delineated in red.

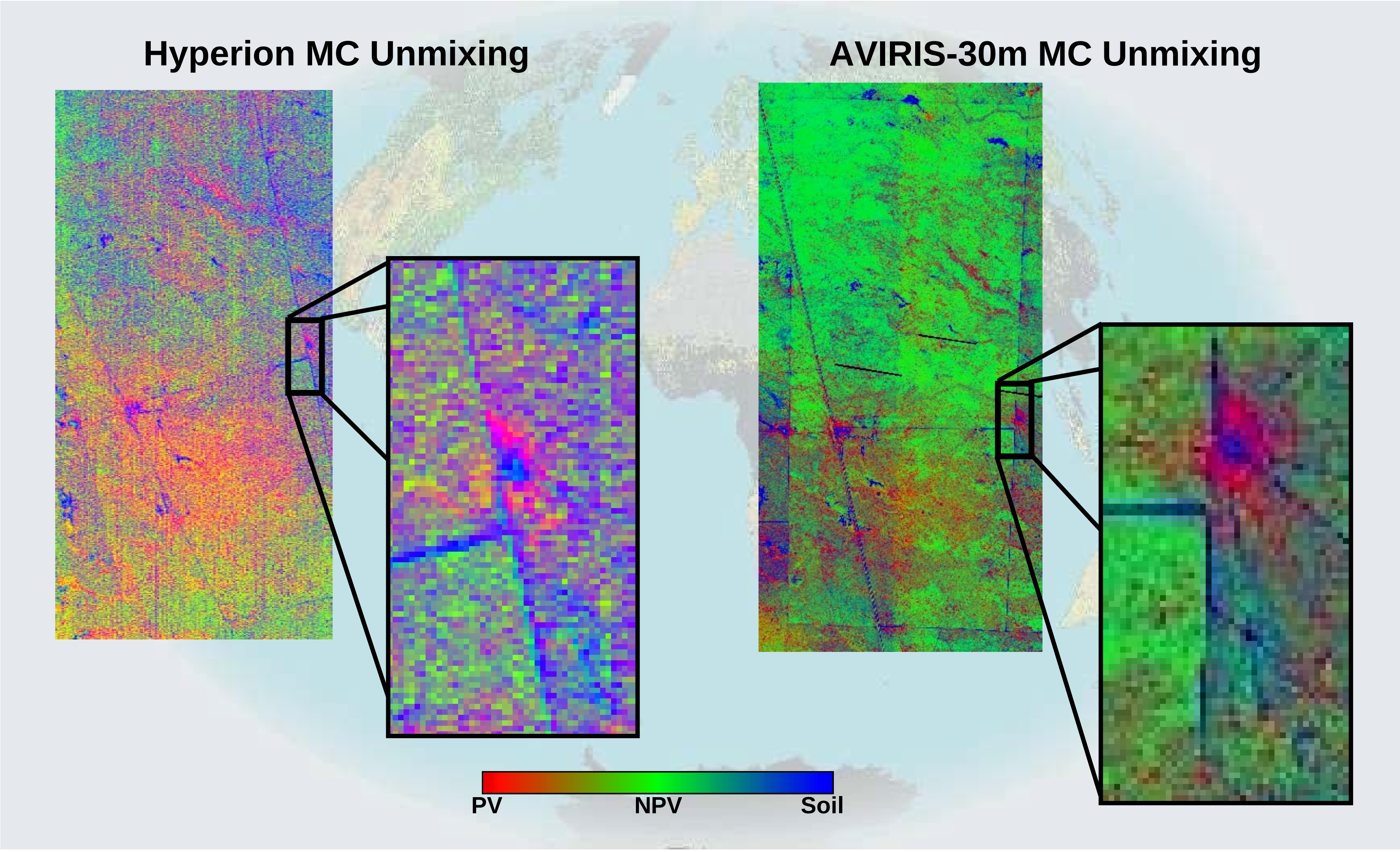
Forest structure, biomass and species richness maps estimated from Hyperion



a) canopy height (m); b) Shannon species richness;
c) biomass (kg/0.1 ha); d) basal area (m2/ha)

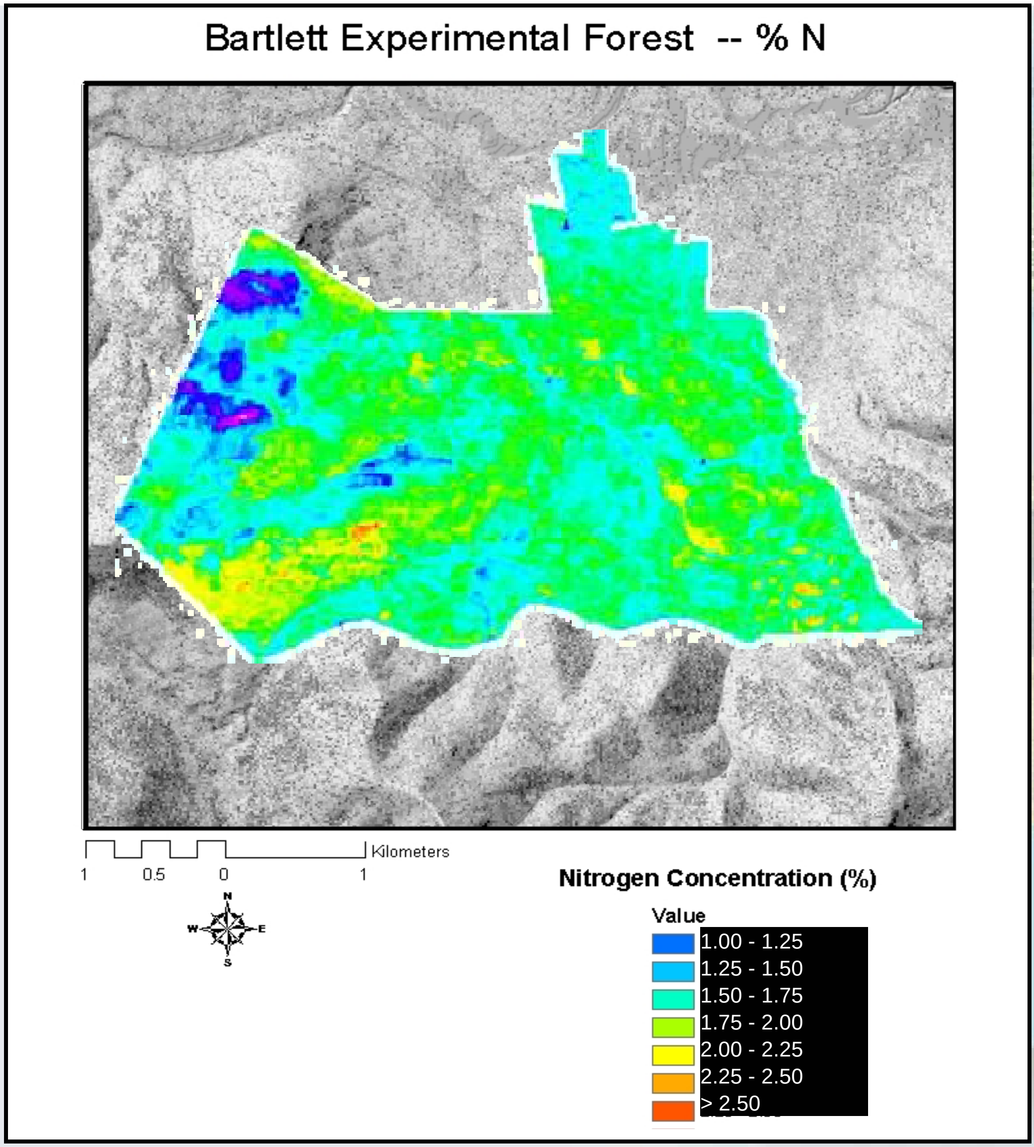
(Kalacska et al. 2007)

Desertification in Central Argentina



Asner et al.

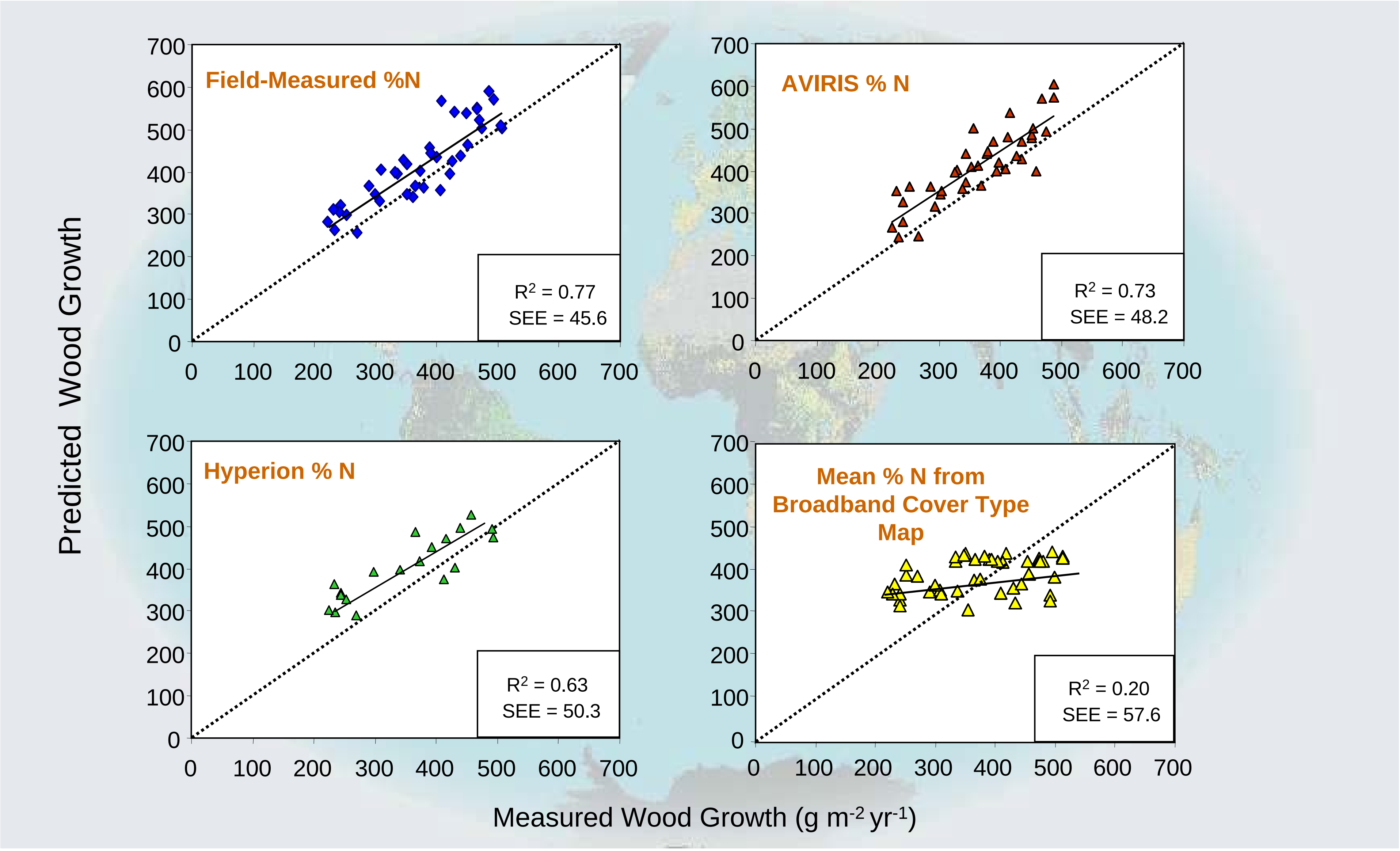
Predicted Canopy Nitrogen



Field Sampling for Canopy Structure, Canopy Chemistry & Wood Growth

Ollinger et al. (2003)

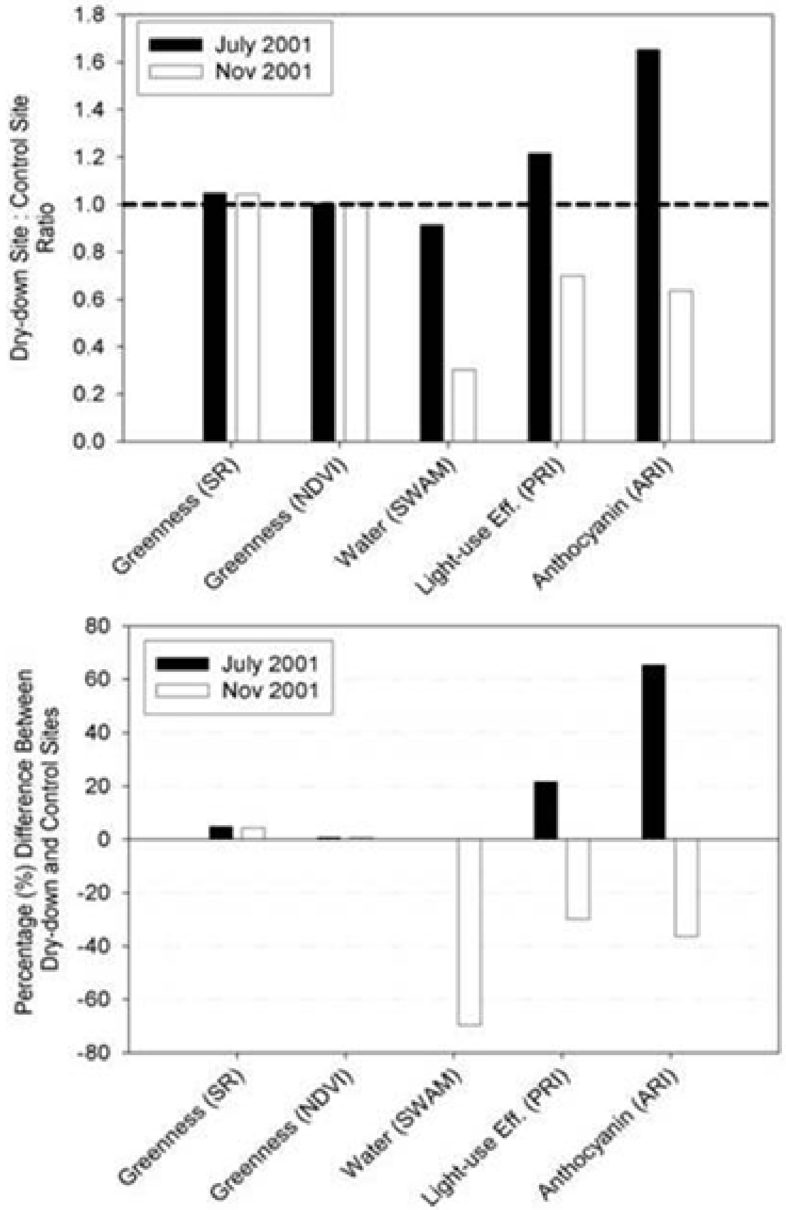
4-way model validation, Bartlett Experimental Forest



Ollinger et al. (2003)

Tropical Forest NPP from Field, Remote Sensing and Modeling Combinations

Spectral Bio-Indicators, Hyperion



Ratio of net primary production in dry-down and control forest stands ($NPP_{d:c}$) for the year 2001, simulated using satellite data and the CASA model (Field et al. 1995).

Scenario	$NPP_{d:c}$(2001)
(1) NDVI	0.98
(2) NDVI, PRI	0.85
(3) SWAM	0.69
(4) SWAM, PRI	0.67
(5) LAI	0.99
(6) LAI, PRI	0.84
(7) Field measurements	0.73

Asner et al.

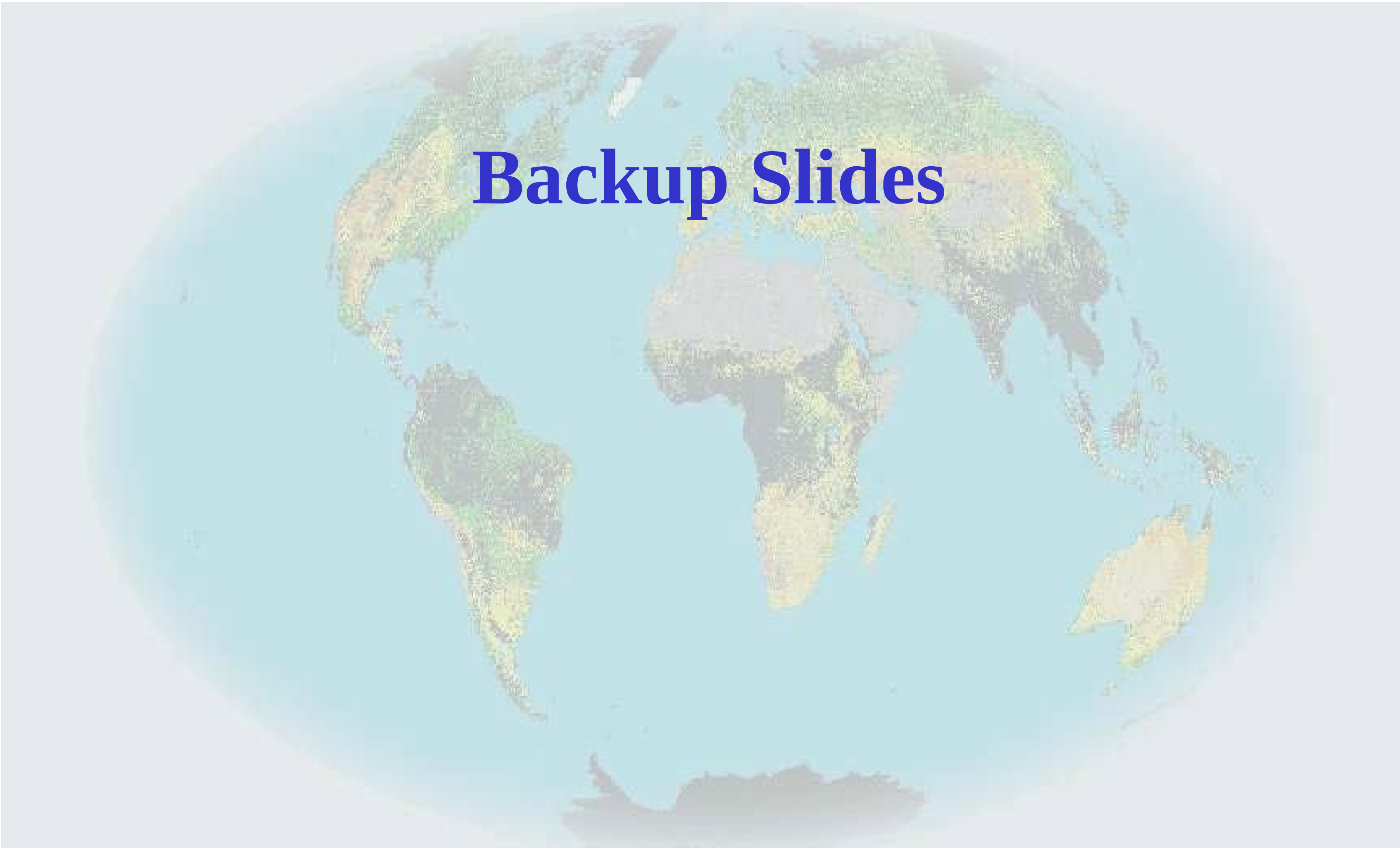
GSFC HyspIRI Science Support

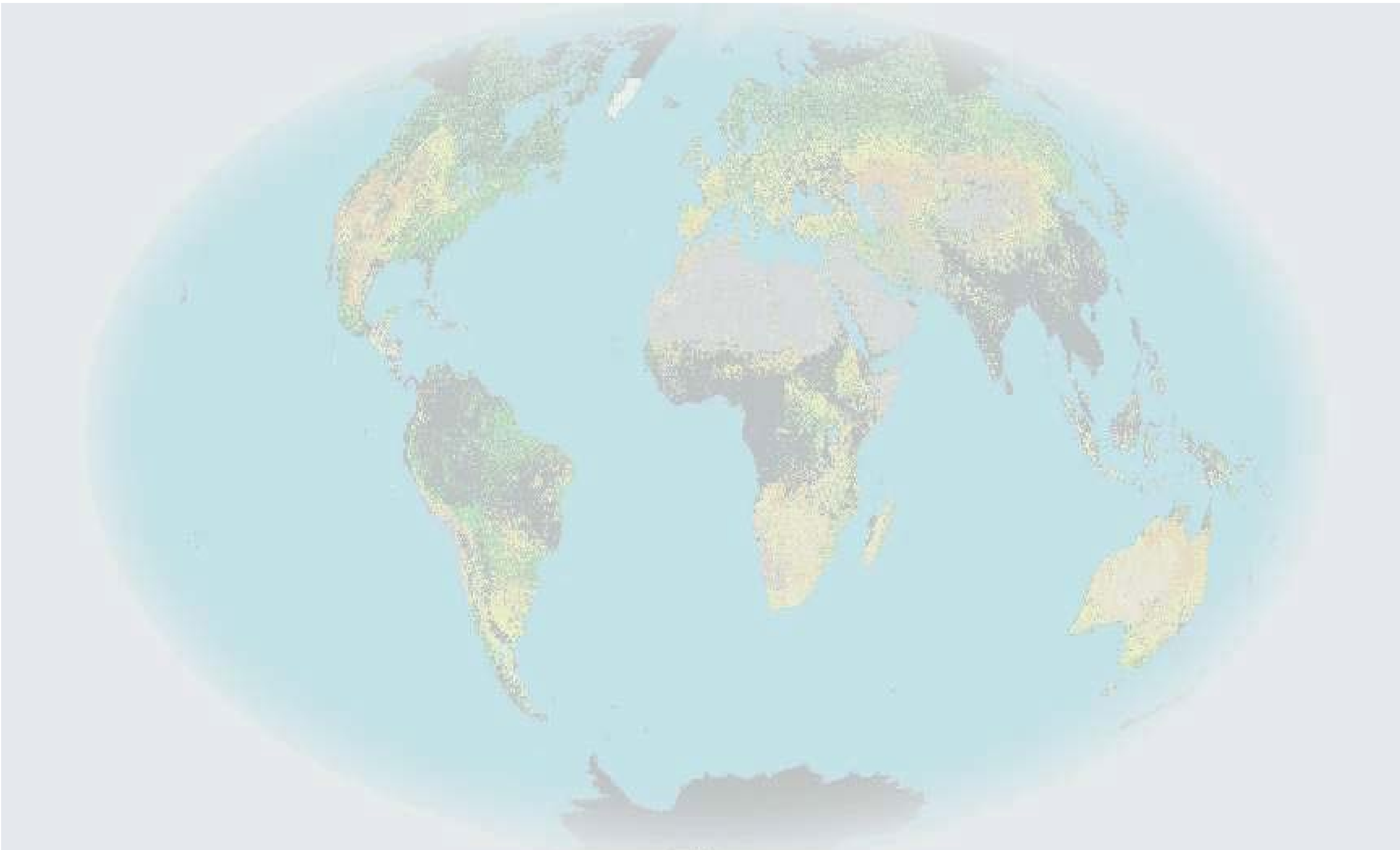
- We continue to utilize EO-1 assets to evaluate and plan HyspIRI products and algorithms.

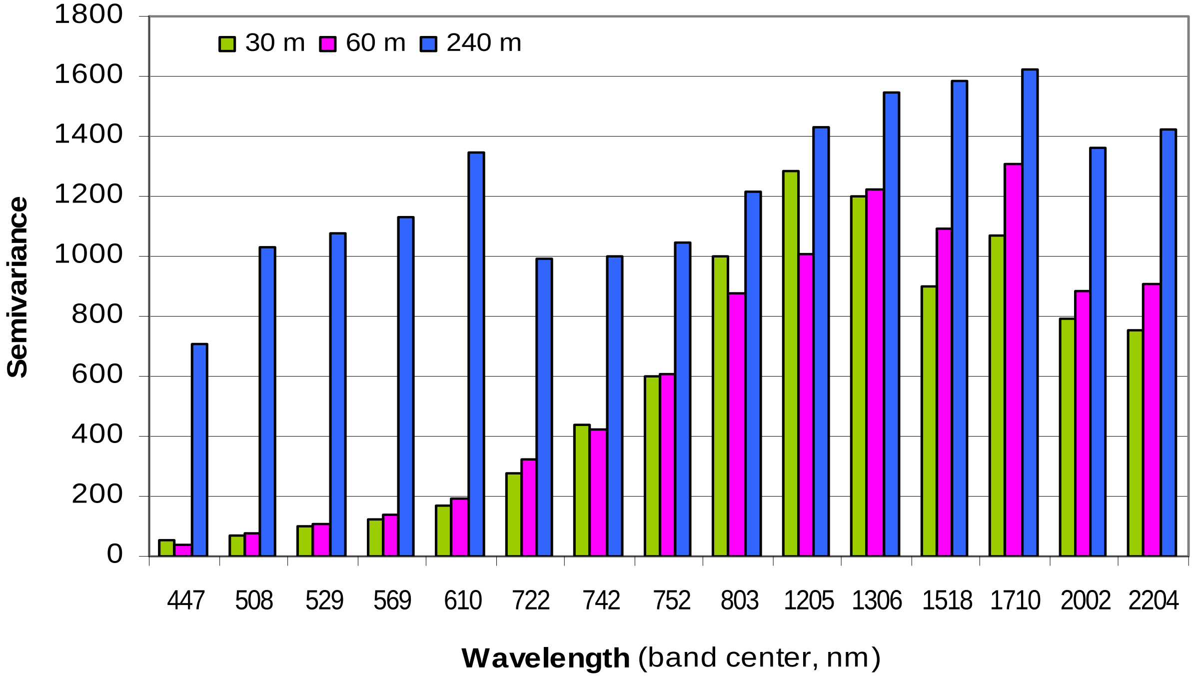
Betsy Middleton
Petya Campbell
Qingyuan Zhang
Yen-Ben Cheng
Larry Corp
Lawrence Ong
Stu Frye
Dan Mandl
Nathan Pollack

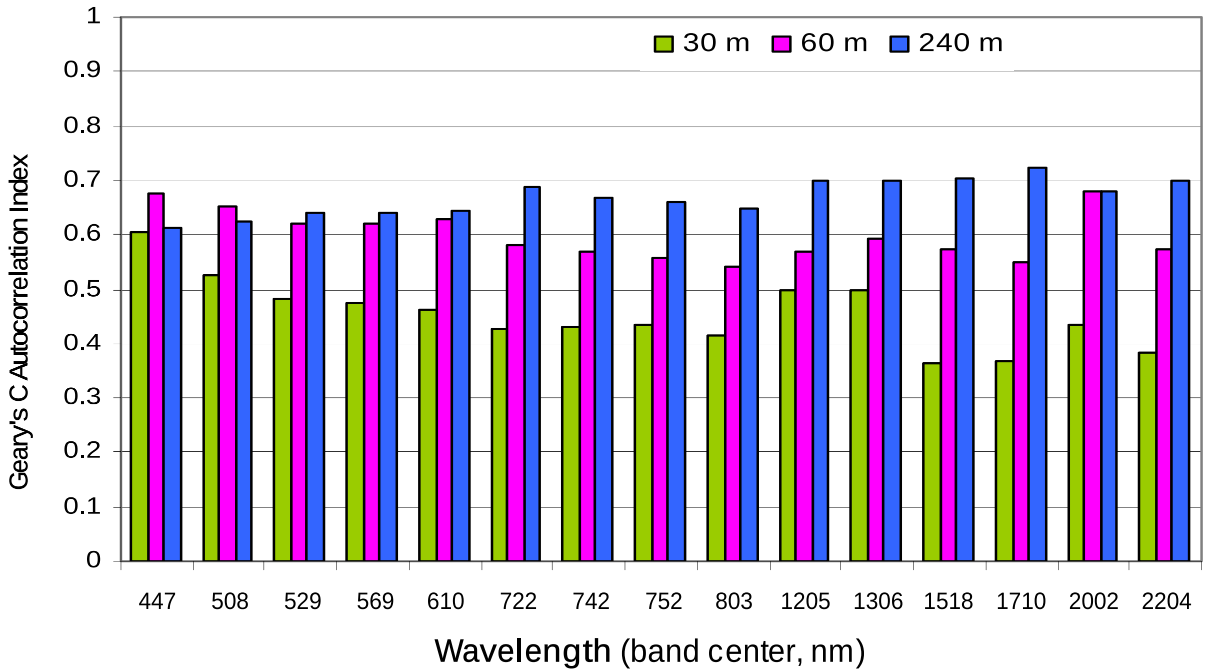
Steve Ungar
Kurt Thome
Bob Knox
Fred Huemmrich

Backup Slides



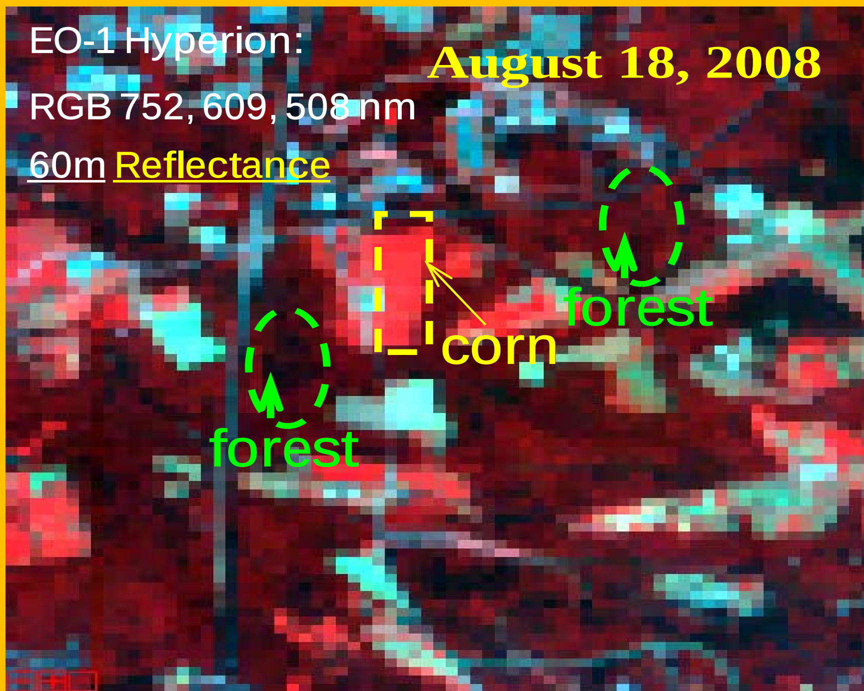


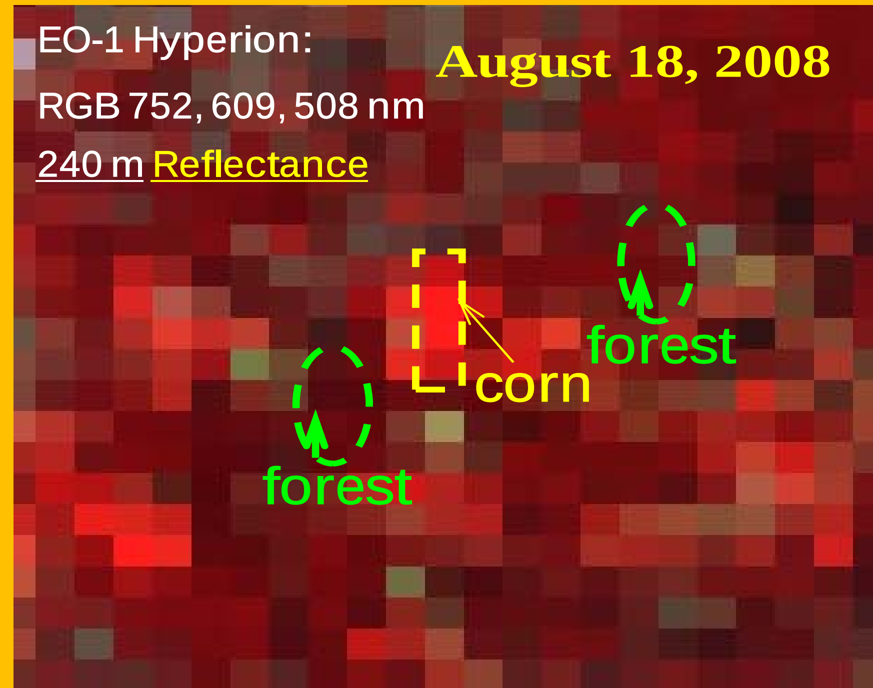




The Global Semivariance provides a single value that describes the spatial autocorrelation of the data within a spectral band.

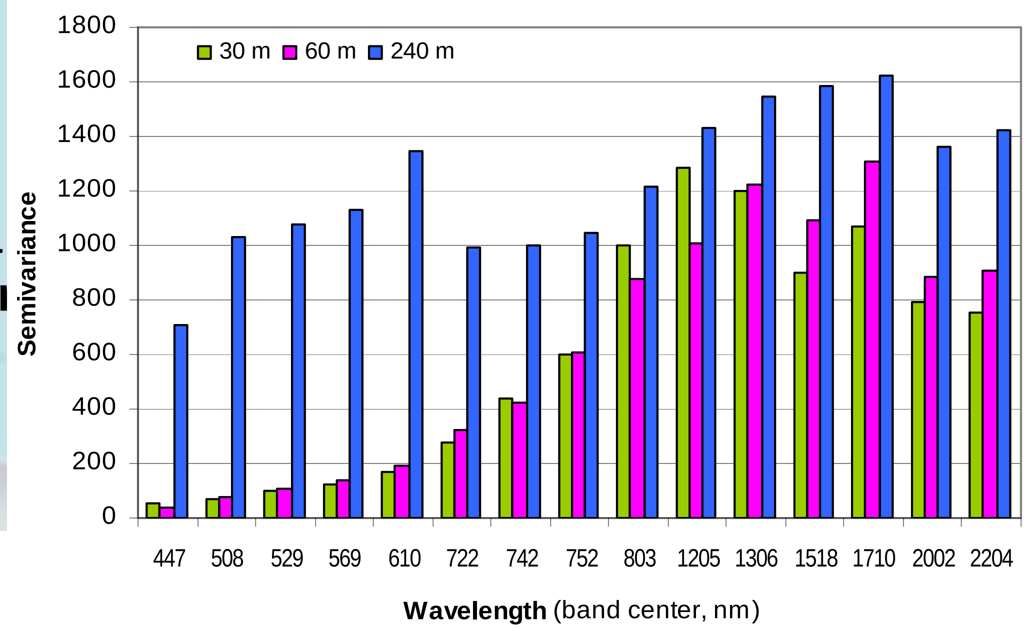
The Geary's C index provides a measure of dissimilarity within the data.





EO-1 Hyperion image acquired in August 18, 2008 aggregated to 60 & 240 m pixels

The Global Semivariance (describing the spatial autocorrelation of the data within a spectral band) is quite similar for 30 m and 60 m pixels, and significantly different for the 240 m.



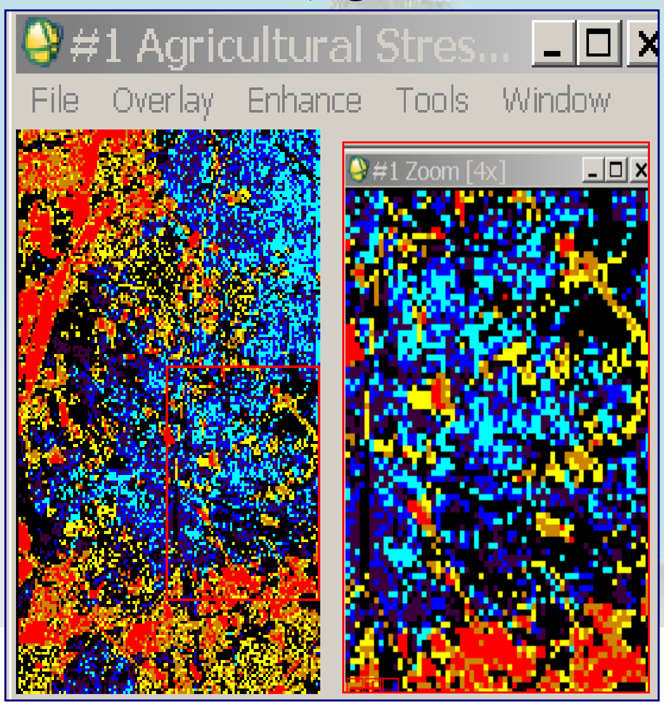
Developing Higher level EO-1 Hyperion Science Products

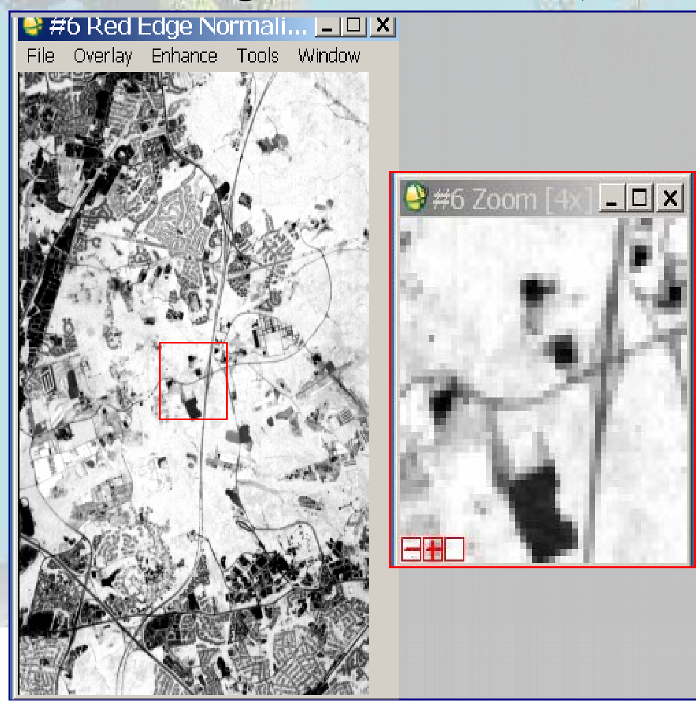
Vegetation Indices and Albedo for major Crops and Land Cover Types (example for Greenbelt, MD)

Pixel size	Vegetation Indices*						Albedo		
	V1	PRI	REIP	Dmax	NDWI	NDVI	water	corn	forest
30 m	1.81	-0.14	721	0.749	0.14	0.81	0.03	0.20	0.14
60 m	1.88	-0.15	721	0.748	0.15	0.82	0.04	0.20	0.13

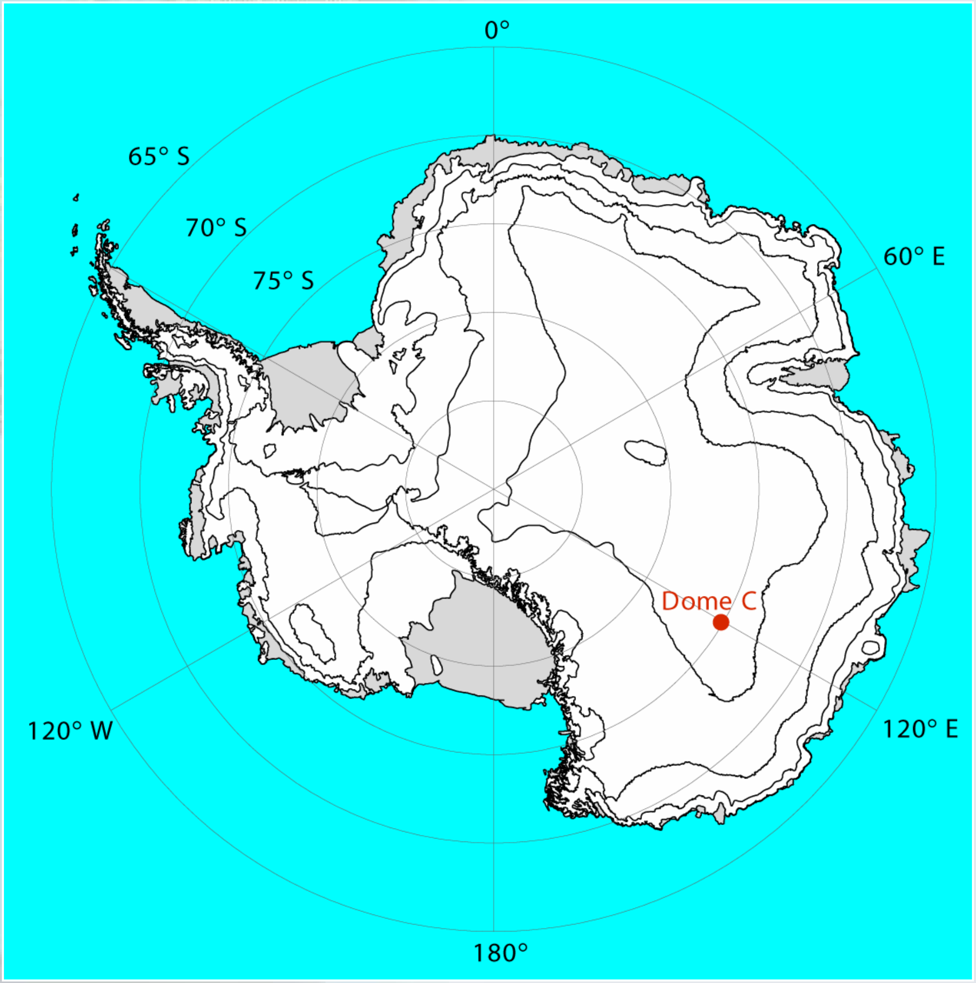
* Reported means, no statistically significant differences established

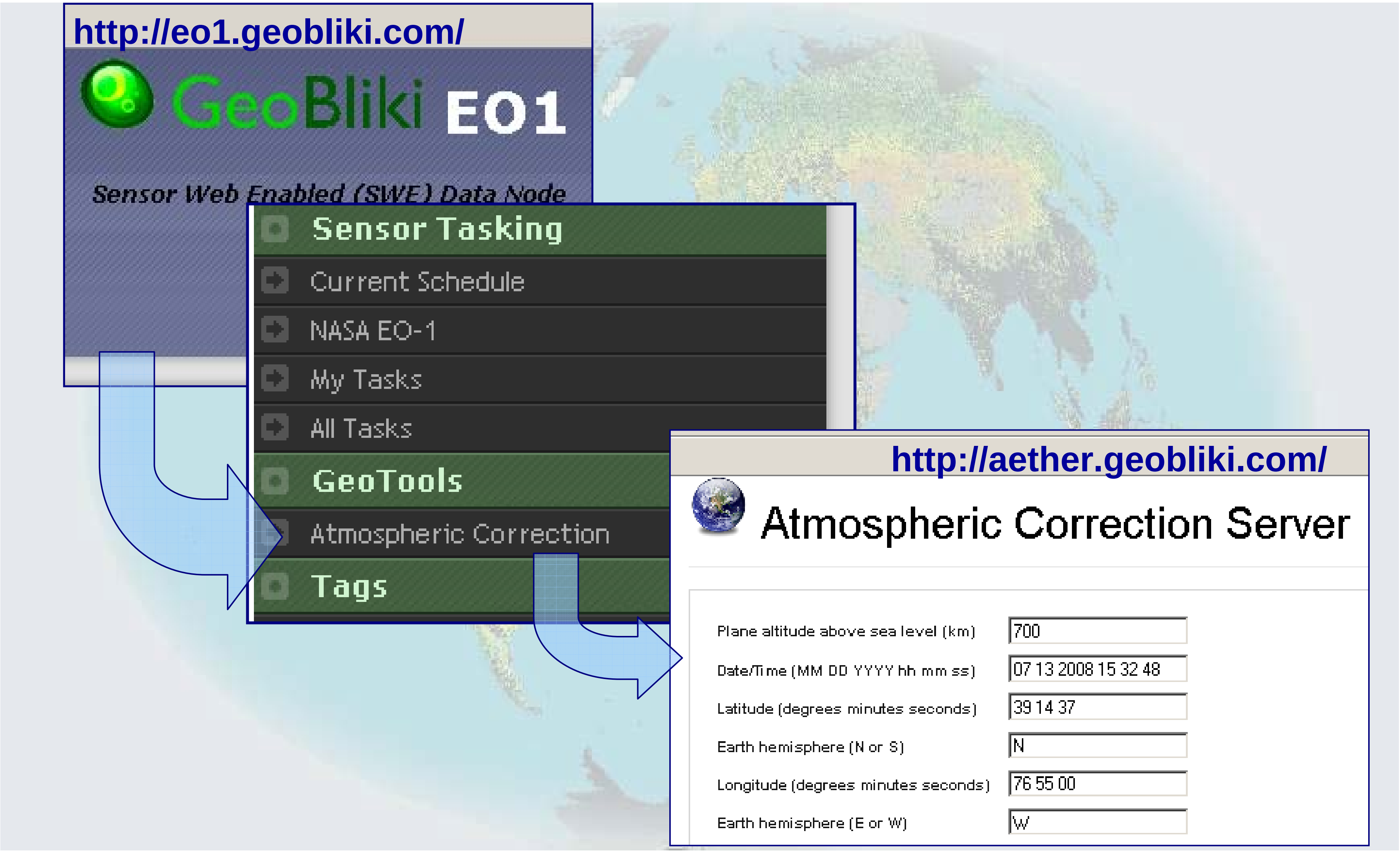
- **Enabling conventional users to conduct their own assessments, using software such as ENVI (Agricultural stress and Red edge Greenbelt, MD)**





- Dome C
  75°S, 123°E, 3250 m
- Very small surface slope results in light winds and small surface roughness
- Cold, fine-grained snow all year
- Similar surface to most of East Antarctic Plateau above 3000 m





http://eo1.geobliki.com/
GeoBliki EO1
Sensor Web Enabled (SWE) Data Node
Sensor Tasking
Current Schedule
NASA EO-1
My Tasks
All Tasks
GeoTools
Atmospheric Correction
Tags
http://aether.geobliki.com/
Atmospheric Correction Server
Plane altitude above sea level (km)
700
Date/Time (MM DD YYYY hh mm ss)
07 13 2008 15 32 48
Latitude (degrees minutes seconds)
39 14 37
Earth hemisphere (N or S)
N
Longitude (degrees minutes seconds)
76 55 00
Earth hemisphere (E or W)
W