NRC Recommended Missions - Early/Mid

Mission	Mission Description	Orbit	Instruments	
Tier #1				
CLARREO (NASA portion)	Solar and Earth radiation: spectrally resolved forcing and response of the climate system	LEO, Precessing	Absolute, spectrally-resolved interferometer	
SMAP	Soil moisture and freeze/thaw for weather and water cycle processes	LEO, SSO	L-band radar L-band radiometer	
ICESat-II	Ice sheet height changes for climate change diagnosis	LEO, Non-SSO	Laser altimeter	
DESDynI	Surface and ice sheet deformation for understanding natural hazards and climate; vegetation structure for ecosystem health	LEO, SSO	L-band InSAR Laser altimeter	
Tier #2				
HyspIRI	Land surface composition for agriculture and mineral characterization; vegetation types for ecosystem health	LEO, SSO	Imaging spectrometer Multiband Thermal	
ASCENDS	Day/night, all-latitude, all-season CO_2 column integrals for climate emissions	LEO, SSO	Multifrequency laser	
SWOT	Ocean, lake, and river water levels for ocean and inland water dynamics	LEO, SSO	Ka-band wide swath radar C-band radar	
GEO-CAPE	Atmospheric gas columns for air quality forecasts; ocean color for coastal ecosystem health and climate emissions	GEO	High and low spatial resolution hyperspectral imagers	
ACE	Aerosol and cloud profiles for climate and water cycle; ocean color for open ocean biogeochemistry	LEO, SSO	Backscatter lidar Multiangle polarimeter Doppler radar	

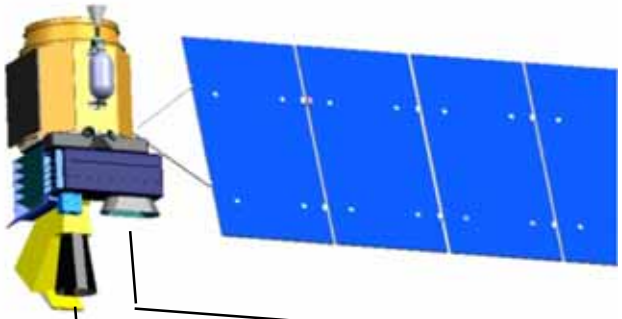
NASA Decadal Survey Mission

HysplRI

Visible ShortWave InfraRed (VSWIR) Imaging Spectrometer

+

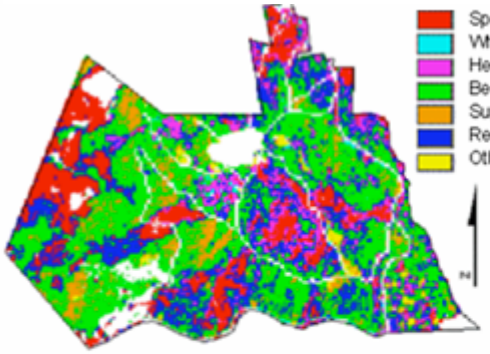
Multispectral Thermal InfraRed (TIR) Scanner

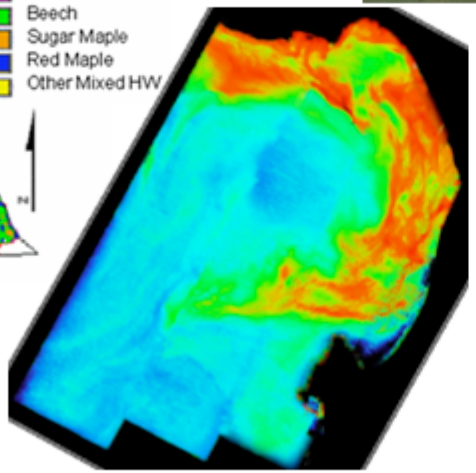


VSWIR: Plant Physiology and Function Types (PPFT)

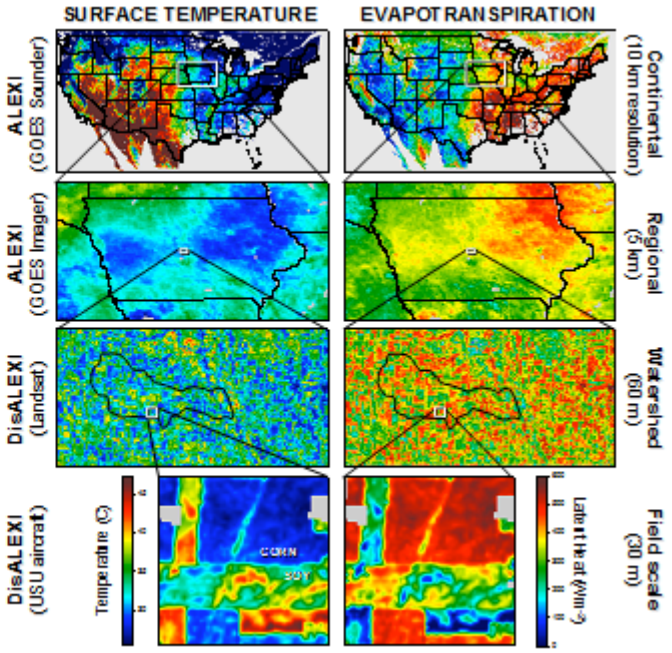
Multispectral TIR Scanner

Map of dominant tree species, Bartlett Forest, NH





Red tide algal bloom in Monterey Bay, CA

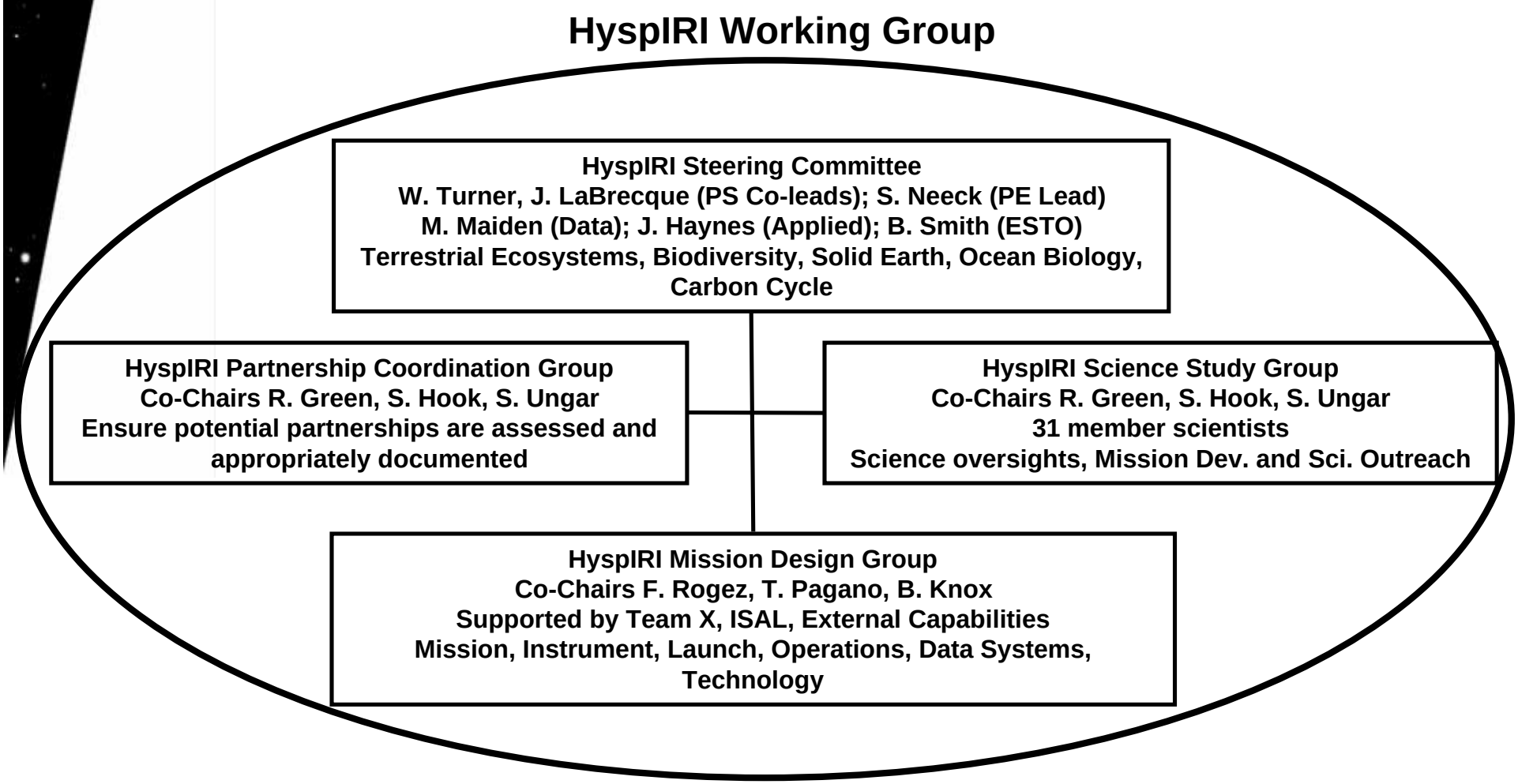


Previous and Current Studies

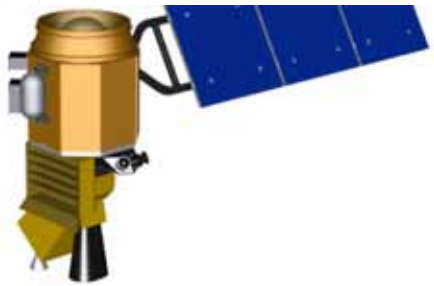
- HyspIRI consists of a visible shortwave infrared (VSWIR) imaging spectrometer and a multispectral thermal infrared (TIR) scanner
- Initial studies for the mission and both instruments were undertaken in 2007 and reported out to NASA HQ in fall 2007.
- A follow-up HypspIRI mission study is now underway utilizing the 2007 mission and instrument design studies. The study is being led at NASA HQ by Woody Turner and John Labrecque (Project Scientists) and Steve Neeck (Program Executive). The execution structure is shown on the next page.
- The VSWIR imaging instrument (aka Plant Physiology and Functional Types spectrometer) [PPFT] study was led by Rob Green
- The multispectral TIR imaging instrument study was led by Simon Hook
- A small science study group for the HyspIRI mission has been identified by NASA HQ which will help refine the scientific requirements and refine the science goals for the mission.
- A science workshop will be held in the fall of 2008 to maximize community involvement and understanding of the mission

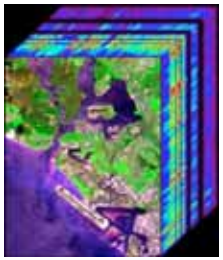
HyspIRI Execution Structure

The HyspIRI Working Group (HWG) will be managed by the HyspIRI Steering Committee with representatives of the principal HyspIRI scientific disciplines. The HWG will coordinate the activities of the Science Study Group, the Partnership Coordination Group and the Mission Design Group



Plant Physiology and Functional Types
NASA Decadal Survey
Mission Concept Study





Imaging spectrometer: 100kg / 67W

Schedule: 4 year phase A-D, 3 years operations

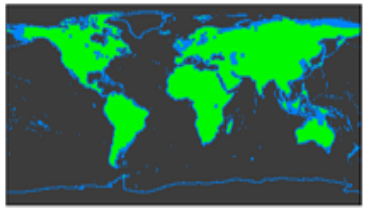
All components have flown in space

Science Questions:

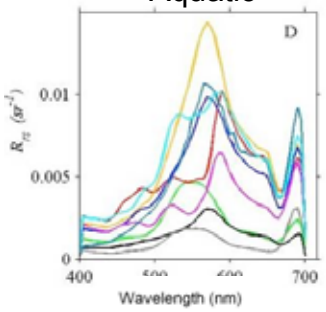
- *What is the composition, function, and health of land and water ecosystems?*
- *How are these ecosystems being altered by human activities and natural causes?*
- *How do these changes affect fundamental ecosystem processes upon which life on Earth depends?*

Measurement:

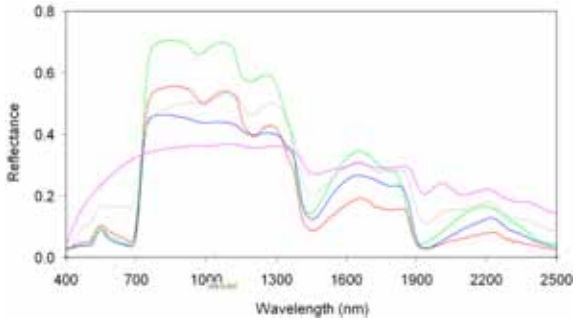
- 380 to 2500 nm in 10nm bands
- Accurate 60 m, 145 km swath
- 19 days revisit at equator
- Global land and shallow water



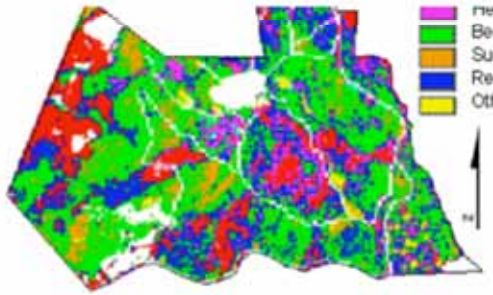
Aquatic

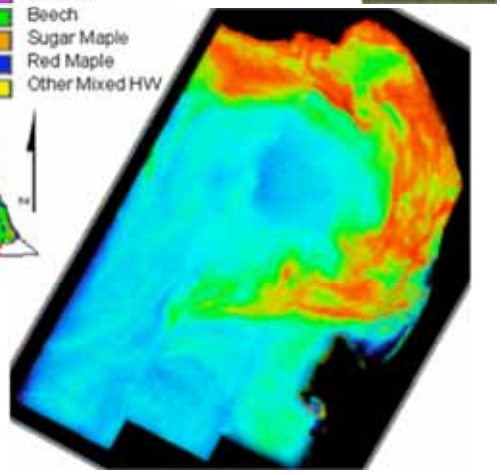


Terrestrial



Map of dominant tree species, Bartlett Forest, NH





Red tide algal bloom in Monterey Bay, CA

PPFT

Overarching Science Questions

- What is the composition, function, and health of terrestrial and aquatic ecosystems?
- How are these ecosystems being altered by human activities and natural causes?
- How do these changes affect fundamental ecosystem processes upon which life on Earth depends?

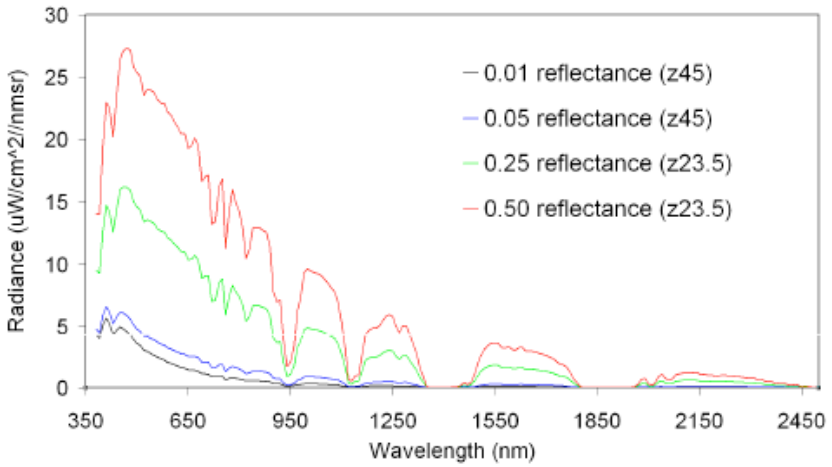
PPFT Science Topic Questions

- Ecosystem Function and Diversity:
  - *What are the spatial distributions of different plant functional groups, diagnostic species, and ecosystems?*
  - *How do their locations and function change seasonally and from year to year?*
  - *What are the trends?*
- Biogeochemical Cycles:
  - *How do changes in the physical, chemical, and biotic environment affect the productivity, carbon storage and biogeochemical cycling processes of ecosystems?*
  - *How do changes in biogeochemical processes feed back to other components of the Earth system?*
- Ecosystem Response to Disturbance:
  - *How do human-caused and natural disturbances affect the distribution, biodiversity and functioning of ecosystems?*
- Ecosystems and Human Well-being:
  - *How do changes in ecosystem composition and function affect human health, resource use, and resource management?*

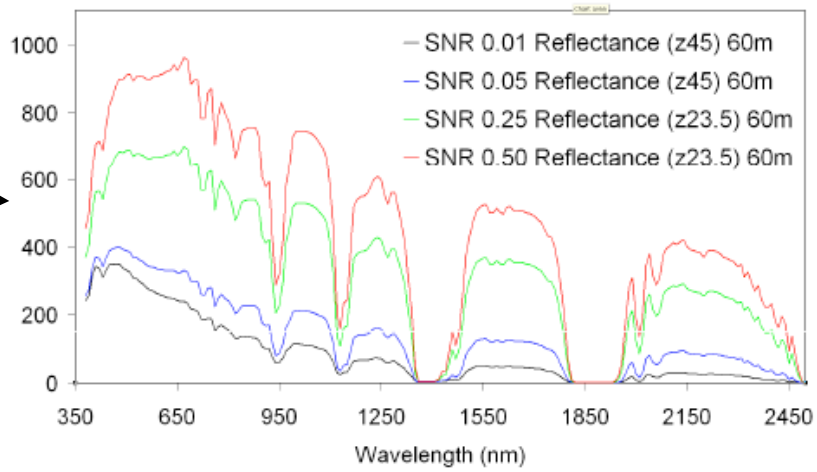
PPFT Measurement

HyspIRI PPFT	
Pixel size (m)	60 (45 DS)
Swath width (km)	145 (90 DS)
Temporal revisit (days)	19 (31 DS)
Orbit altitude (km)	623
Accuracy	>95% absolute radiometric 98 % on-orbit reflectance
Number of bands	213
Spectral sampling (nm)	10
S:N	
Wavelength range (nm)	380-2500
Equator overpass	11 am descending
Uniformity	**>95%**

Benchmark Radiances



Required SNR

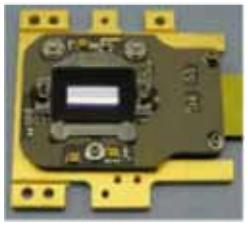


Instrument: Offner Spectrometer
Low Cost and High Fidelity

- The instrument design selected is an Offner imaging spectrometer with extensive relevant heritage
  - *Hyperion, CRISM, COMPASS^{air}, TB^{air}, ARTEMIS, M3*
- At the core of the PPFT instrument is a pair of f/2.5, high signal-to-noise ratio, uniform, full-spectral-range Offner spectrometers

Each spectrometer has two full range detector arrays that cover the spectral range from 380 to 2500 nm @ 10 nm intervals with 610 cross-track spatial elements used

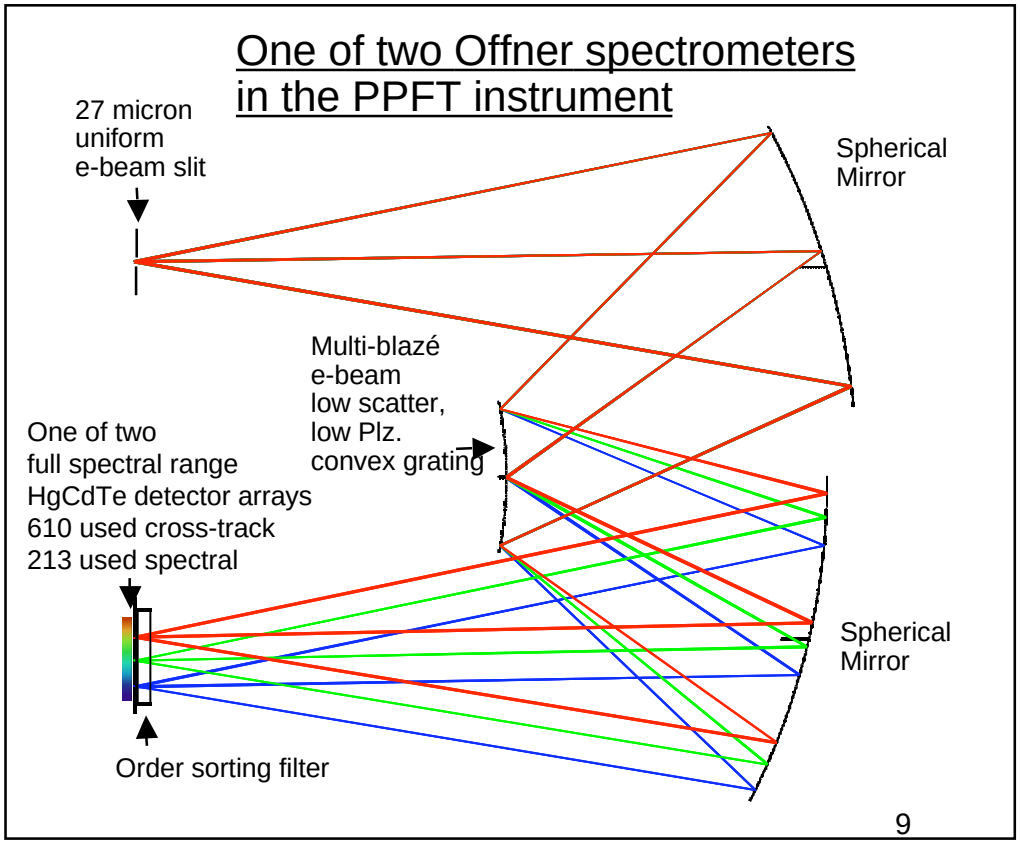
- CRISM, TB^{air}, ARTEMIS^{full_range}, M3^{full_range}



Full range Detector array and filter

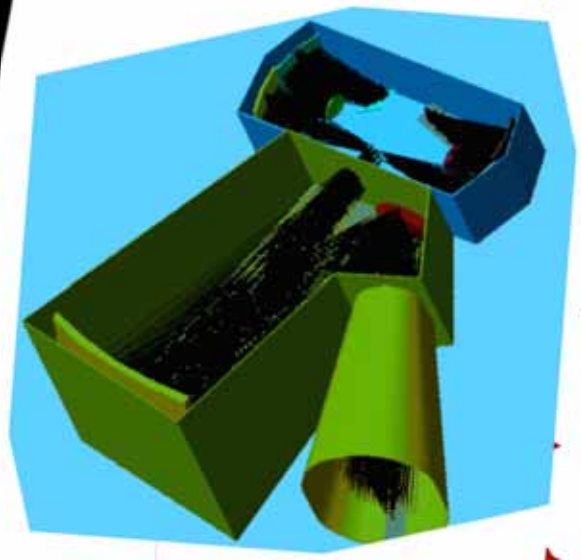
Convex multi-blaze grating

Uniform air slit

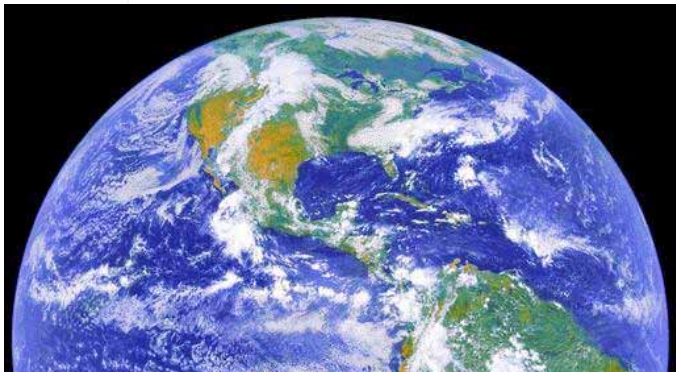


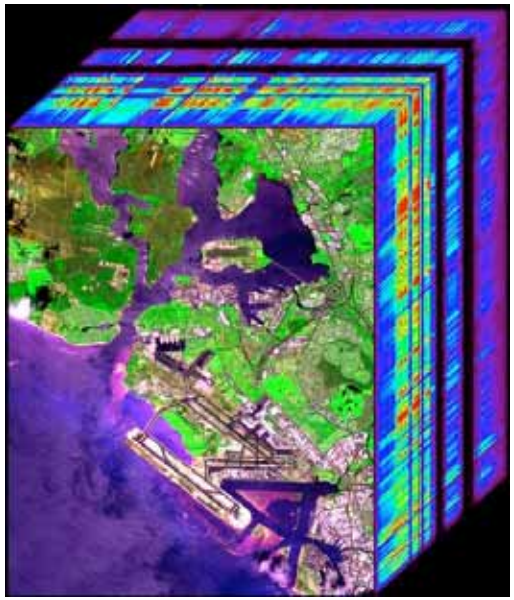
Key Instrument Performance Parameters

PPFT Imaging Spectrometer

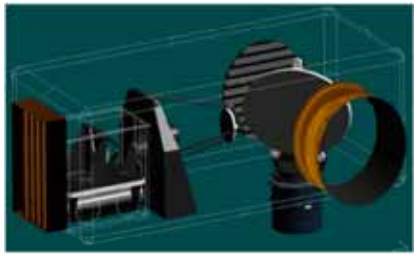


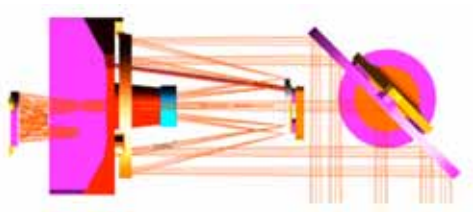
- Meets all measurement requirements
- Mass: <100 kg
- Power: 67 watts
- Volume: 1.6 X 1.6 X 1
- Lossless compression: 3.0
- Downlink: 640 mbits/second





Thermal Infrared Multispectral Scanner
NASA Mission Concept Study





TIR Multispectral Scanner: 45.3kg / 41.9W

Instrument cost (FY07$M): 40M

Schedule: 4 year phase A-D, 3 years operations

All components have flown in space

Science Questions:

Q1. Volcanoes: What are the changes in the behavior of active volcanoes? Can we quantify the amount of material released into the atmosphere by volcanoes and estimate its impact on Earth's climate? How can we help predict and mitigate volcanic hazards?

Q2. Wildfires: What is the impact of global biomass burning on the terrestrial biosphere and atmosphere, and how is this impact changing over time?

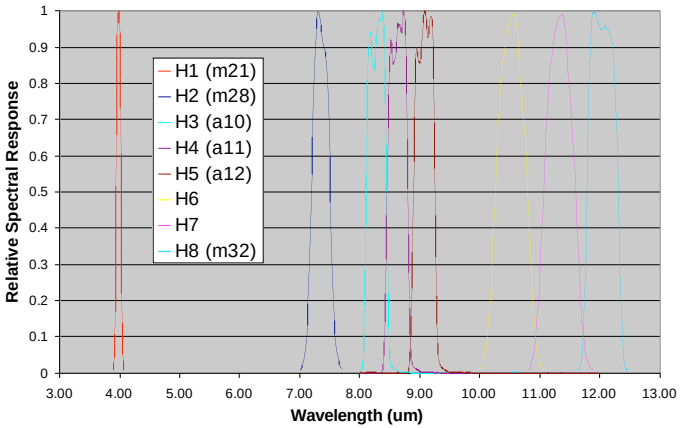
Q3. Water Use and Availability: As global freshwater supplies become increasingly limited, how can we better characterize trends in local and regional water use and moisture availability to help conserve this critical resource?

Q4. Urbanization: How does urbanization affect the local, regional and global environment? Can we characterize this effect to help mitigate its impact on human health and welfare?

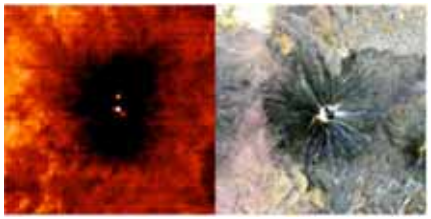
Q5. Land surface composition and change: What is the composition and temperature of the exposed surface of the Earth? How do these factors change over time and affect land use and habitability?

Measurement:

- 7 bands between 7.5-12 μm and 1 band at 4 μm
- 45 m resolution, 5 days revisit
- Global land and shallow water

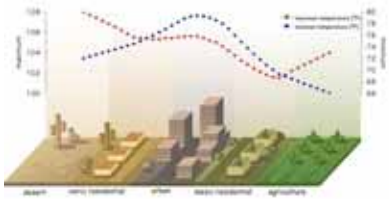


Andean volcano heats up

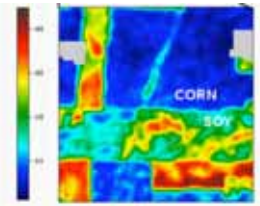


Volcanoes

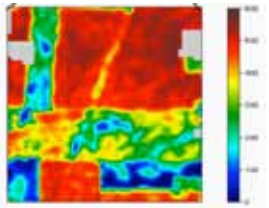
Urbanization



Water Use and Availability



Surface Temperature



Evapotranspiration

TIR Overarching Science Questions

- ***Q1. Volcanoes*** *What are the changes in the behavior of active volcanoes? Can we quantify the amount of material released into the atmosphere by volcanoes and estimate its impact on Earth's climate? How can we help predict and mitigate volcanic hazards?*
- ***Q2. Wildfires*** *What is the impact of global biomass burning on the terrestrial biosphere and atmosphere, and how is this impact changing over time?*
- ***Q3. Urbanization*** *How does urbanization affect the local, regional and global environment? Can we characterize this effect to help mitigate its impact on human health and welfare?*
- ***Q4. Water Use and Availability*** *As global freshwater supplies become increasingly limited, how can we better characterize trends in local and regional water use and moisture availability to help conserve this critical resource?*
- ***Q5. Land surface composition and change*** *What is the composition and temperature of the exposed surface of the Earth? How do these factors change over time and affect land use and habitability?*

- A set of sub-questions has been developed for each overarching question and each subquestion has a measurement requirement.

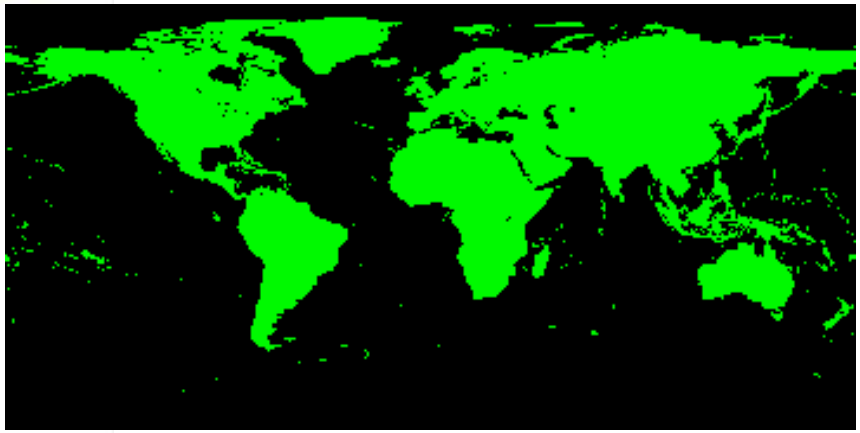
NRC + Science Working Group Recommendations

HyspIRI (NRC)	
Pixel size (m)	< 90
Swath width (km)	400
NE ΔT (K)	0.1
Number of bands	5
Wavelength range (μm)	8-12

HyspIRI (NRC)+ Science Working Group	
Pixel size (m)	60
Swath width (km)	600
Temporal revisit (days)	5
Orbit altitude (km)	623
NEΔT (K)	0.1-0.3
Number of bands	8, 1 band with low gain
Radiance range (band 1-7)	200-400K
Radiance range (band 8)	300-1400K
Wavelength range (μm)	8-12, low gain band at 4.
Equator overpass	11 am descending

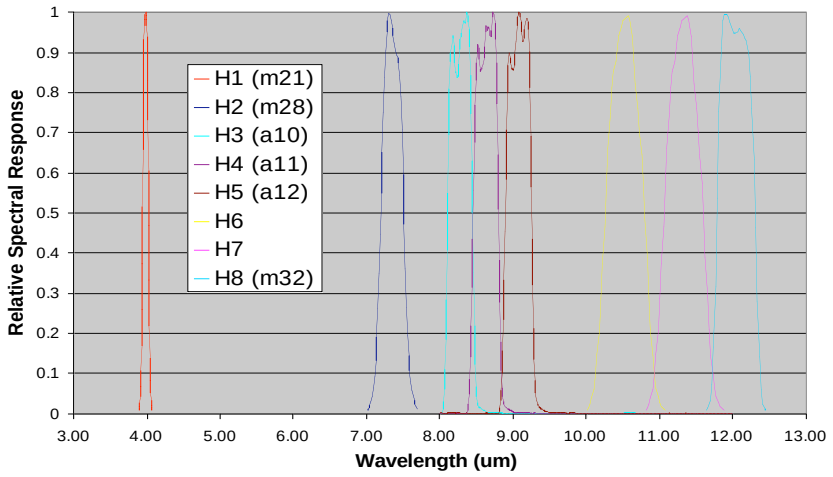
* Hyperspectral wants to point the s/c so we need to be able to accommodate that by pointing our scan mirror.
* Hyperspectral is pointed to start with to avoid glint.

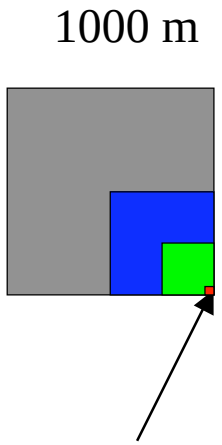
Science Measurements Approach



- Measure the land surface temperature and emissivity
- 5 day equatorial revisit to generate monthly, seasonal and annual products.
- 60 m spatial resolution

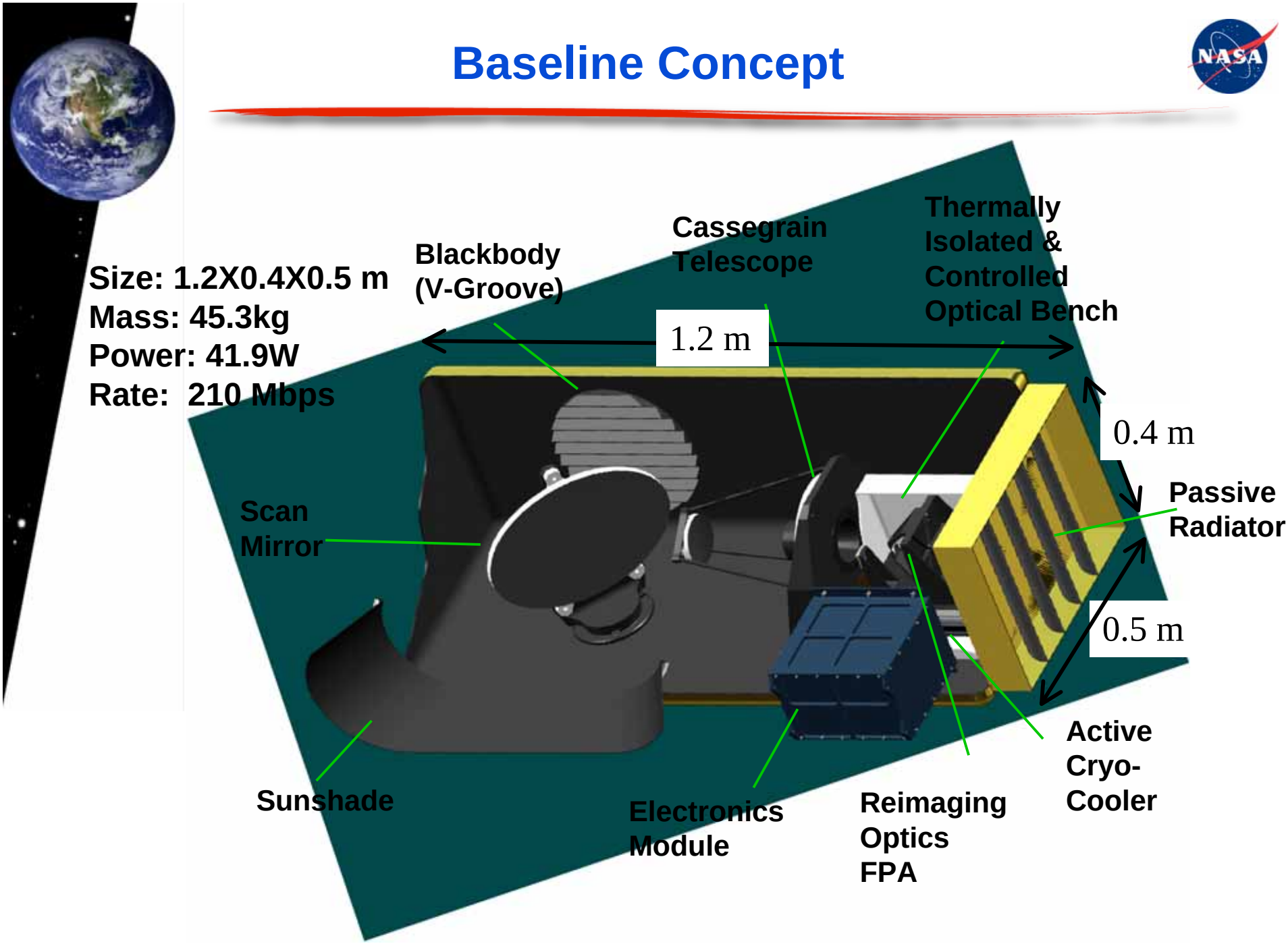
- 7 bands between 7.5-12 µm and 1 band between 3-5 µm
- 3-5 µm band saturates at 1400K
- 7.5-12 µm bands saturate at 400K





TIR at 60 m

Baseline Concept



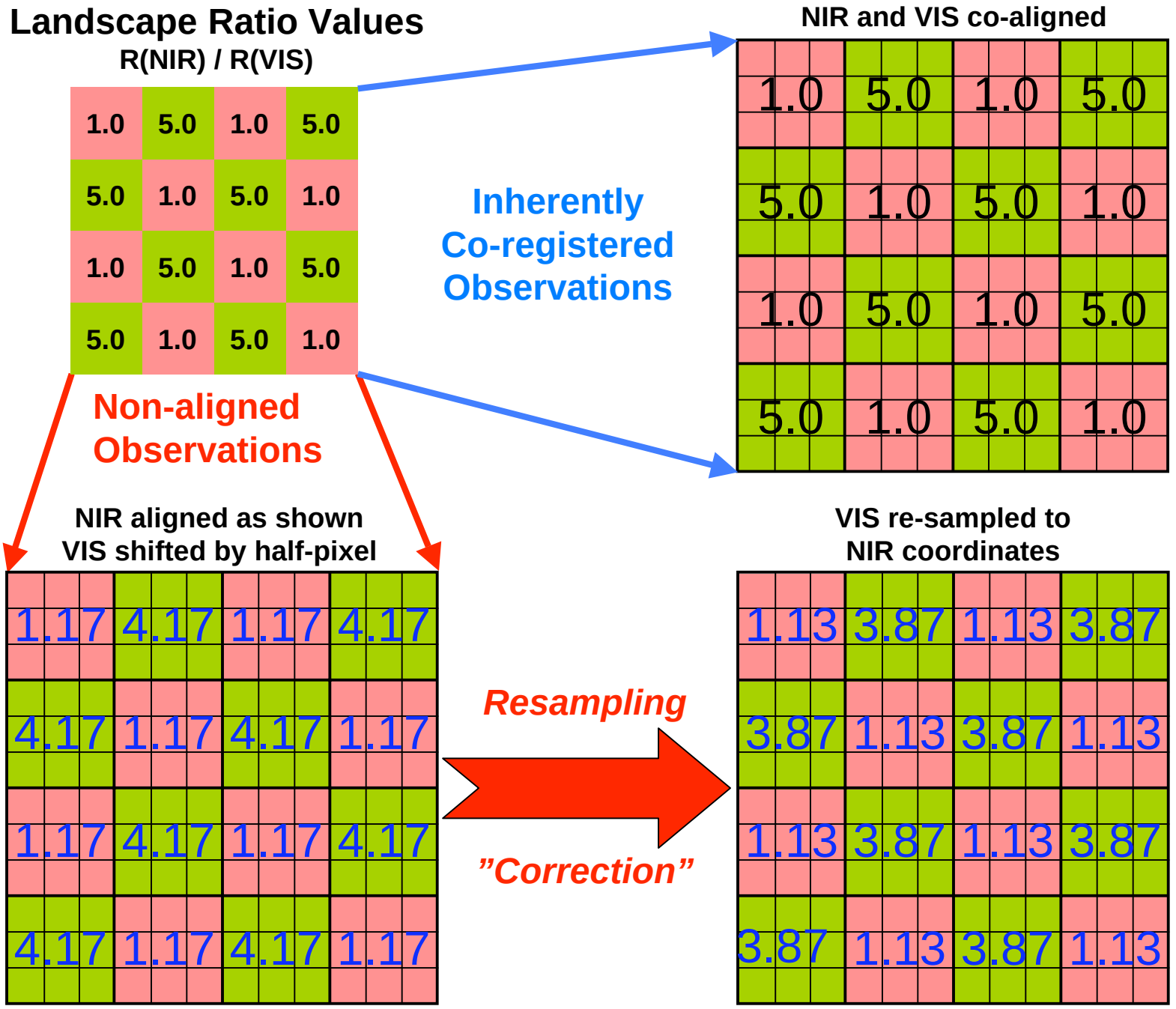
Earth Observing-One (EO-1) Lessons Not Learned

IGARSS - 2008
Boston, USA
July 10, 2008

Stephen Ungar
Dan Mandl
Stuart Frye
Joseph Young
Lawrence Ong

Briefing Overview

- Mission Background
- EO-1 Advanced Land Imager (ALI) “Scanning” Strategy
- Lessons *(Not)* Learned: A Case Study
  Impact of Band-to-Band Misalignment


Landscape Ratio Values
R(NIR) / R(VIS)
1.0 5.0 1.0 5.0
5.0 1.0 5.0 1.0
1.0 5.0 1.0 5.0
5.0 1.0 5.0 1.0
Inherently
Co-registered
Observations
NIR and VIS co-aligned
1.0 5.0 1.0 5.0
5.0 1.0 5.0 1.0
1.0 5.0 1.0 5.0
5.0 1.0 5.0 1.0
Non-aligned
Observations
NIR aligned as shown
VIS shifted by half-pixel
1.17 4.17 1.17 4.17
4.17 1.17 4.17 1.17
1.17 4.17 1.17 4.17
4.17 1.17 4.17 1.17
Resampling
"Correction"
VIS re-sampled to
NIR coordinates
1.13 3.87 1.13 3.87
3.87 1.13 3.87 1.13
1.13 3.87 1.13 3.87
3.87 1.13 3.87 1.13

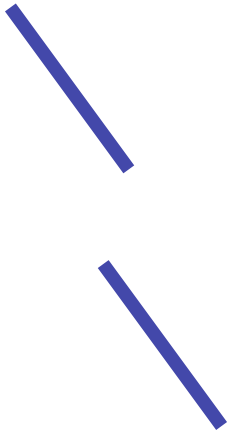
Results of half pixel misalignment and correction through linear resampling

Scenario 1	Category 1 Ratio Value	Category 1 Discrepancy	Category 2 Ratio Value	Category 2 Discrepancy
VIS and NIR co-aligned	1.00	0%	5.00	0%
VIS and NIR misaligned	1.17	+17%	4.17	-17%
VIS realigned by resampling	1.13	+13%	3.87	-23%

Band-to-Band Registration
The Bottom Line

Band-to-Band Registration

However .....



Request from Chris Blackerby, NASA CEOS Secretariat Rep.

Steve,

Here are the two actions that were raised at the CEOS SIT that refer to WGCV:

Both are for agencies to provide responses to CEOS. Will you be able to give feedback on this at Avignon?

Chris

SIT 22-3: CEOS Agencies to respond by Dec 31, 2008 to WGCV request for participation and funding support in its 2009 international radiometer intercomparison campaign/workshop in support of GEO Task DA-06-02

SIT 22-4: CEOS Agencies to provide comments by Oct 31, 2008 on the WGCV data quality assurance (QA4EO) guideline document that WGCV will ask CEOS Plenary to endorse