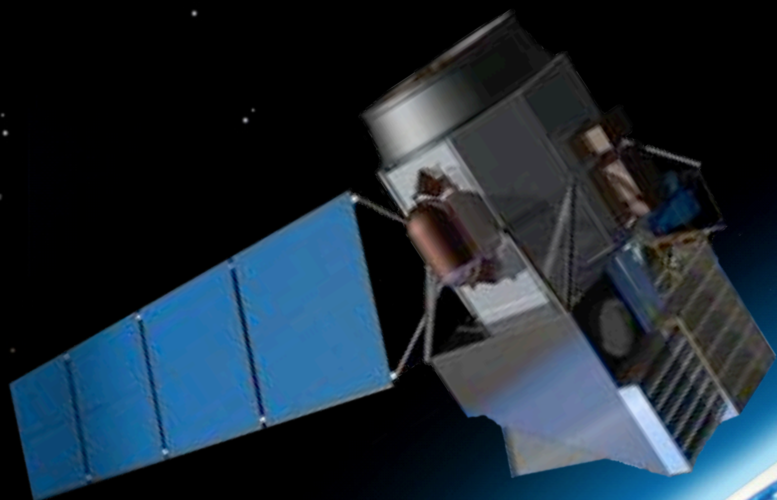
Overview of the 2015 HyspIRI Symposium at NASA's Goddard Space Flight Center June 3-5, 2015



Elizabeth M. Middleton
EO-1 Mission Scientist
2007- present
Biospheric Sciences Laboratory
NASA GSFC, October, 2015

Dan Mandl, Stu Frye, Petya Campbell, Steve Ungar, Chris Neigh, Dave Landis, Fred Huemmrich, Chrissy Frye, Larry Corp, Kevin Turpie, Lawrence Ong, Lisa Henderson

HyspIRI Workshop
Pasadena, CA
October 2015

2015 HyspIRI Mission and Products Symposium

Evolving the HyspIRI Mission and Products: HyspIRI Strategies to Meet Sustainable Land & Aquatic Imaging Needs

NASA/GSFC, June 3 and 4, 2015
Building 34, Conference Room W150

Wireless internet connection:
Choose "Guest-CNE" network

Day One: Wednesday, June 3

- SESSION I-A: HyspIRI: The Fit Within the NASA Program [Chair, Betsy Middleton, GSFC] Overview: HyspIRI accomplishments and plans
- SESSON I-B: SLI and other Relevant Activities [Chair, Betsy Middleton, GSFC]
- SESSION II-A: Efficient Onboard Processing and Product Distribution [Chair, Dan Mandl, GSFC]
- SESSION II-B: Efficient Onboard Processing and Product Distribution [Chair, Dan Mandl, GSFC]
- Thermal Tutorial (Simon Hook, JPL)
- Poster Session Speed Talks (~2 min) & Ice Breaker   (take your poster slide to the AV table by 3 pm)

Day Two: Thursday, June 4

- SESSION III-A: Science and Application Products [Chair, Petya Campbell]
- SESSION III-B: Science and Application Models and Measurements [Chair, Petya Campbell]
- SESSION IV: Cal/Val & Characterizing Hot Targets [Chair, Steve Ungar]
- SESSION IV-A: Daytime Calibration/Validation [Chair, Chris Neigh]
- SESSION IV-B: Nighttime Hyperion Collections [Chair, Steve Ungar]
- SESSION V: What is the Way Forward [Chair, Fred Huemmrich]

- **DINNER at Chinese Restaurant**

Friday, June 5

HyspIRI Aquatic Studies Group (HASG)
3rd Annual Aquatic Forum
Chair, Kevin Turpie

SESSION I – Atmospheric correction over coastal and inland waters: Challenges and priorities for implementing an operational atmospheric correction algorithm over coastal and inland waters.

SESSION II – Hyperspectral data sets for algorithm development: Hyperspectral campaigns (past, present, and future) and what data products are or will be available for the development of hyperspectral remote sensing algorithms.

6th HyspIRI Data Product Symposium, GSFC, Greenbelt, MD

HyspIRI Update

Woody Turner

HyspIRI co-Program Scientist

Earth Science Division

NASA Headquarters

June 3, 2015

HyspIRI Guidance for 2015

(Per 1/12/2015 Guidance Memo from Steve Neeck)

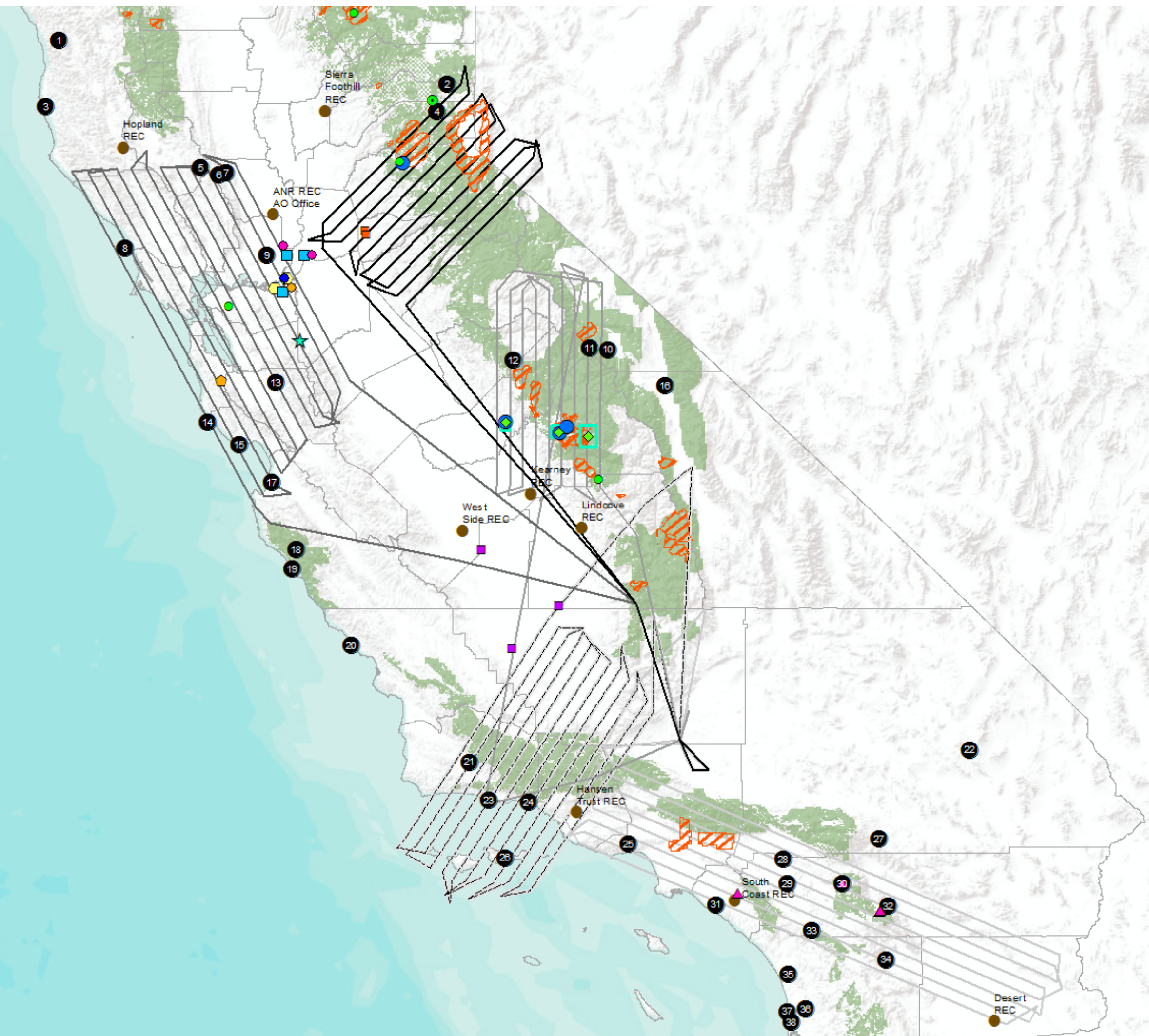
1. Continue to build broad community support via workshops/symposia
2. Continue to conduct HyspIRI data product generation and benchmarking with airborne data
3. Continue to carry out instrument mission trade studies, including smallsat and ISS opportunities, to provide lower cost and more adaptable instrument and/or mission approaches, including for a VSWIR risk reduction concept
4. Continue to explore options to ensure the HyspIRI VSWIR and TIR instruments meet the Sustainable Land Imaging measurement requirement, including compatibility with heritage data product resolution
5. Develop a plan for utilizing the ECOSTRESS mission results for HyspIRI risk reduction
6. Continue to engage potential international and domestic partners in addressing opportunities to lower mission cost while maintaining Level 1 mission requirements
7. Augment the planned FY15 tasks with appropriate activities to further HyspIRI risk reduction utilizing the FY15 $1,000K over guide funding
8. Complete the comprehensive development report of the HyspIRI mission study activities

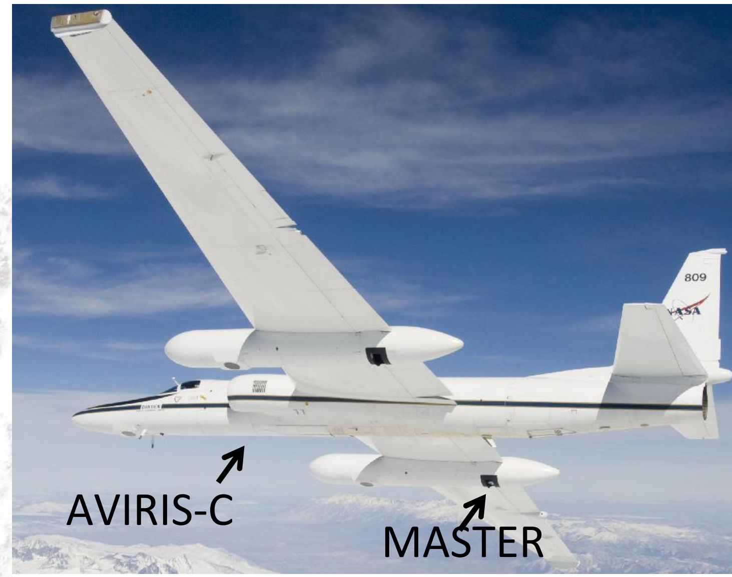
W. Turner

HyspIRI Airborne Preparatory Mission

Datasets to Simulate Future HyspIRI Satellite Imagery

ER-2 Altitude	AVIRIS Resolution	AVIRIS Swath	MASTER Resolution	MASTER Swath
65,000 ft	*20 m*	*12 km*	*50 m*	*35 km*





PI TEAM:
Wendy Calvin/University of Nevada - Reno
Matthew Clark/Sonoma State University
Bo-Cai Gao/Naval Research Laboratory
Bernard Hubbard/USGS
George Jenerette/University of California, Riverside
Thomas Kampe/NEON
Raphael Kudela/University of California, Santa Cruz
Ira Leifer/University of California, Santa Barbara
Shunlin Liang/University of Maryland
Paul Moorcroft/Harvard University
Dar Roberts/University of California, Santa Barbara
Philip Townsend/University of Wisconsin-Madison
Susan Ustin/University of California, Davis
Jan van Aardt/Rochester Institute of Technology

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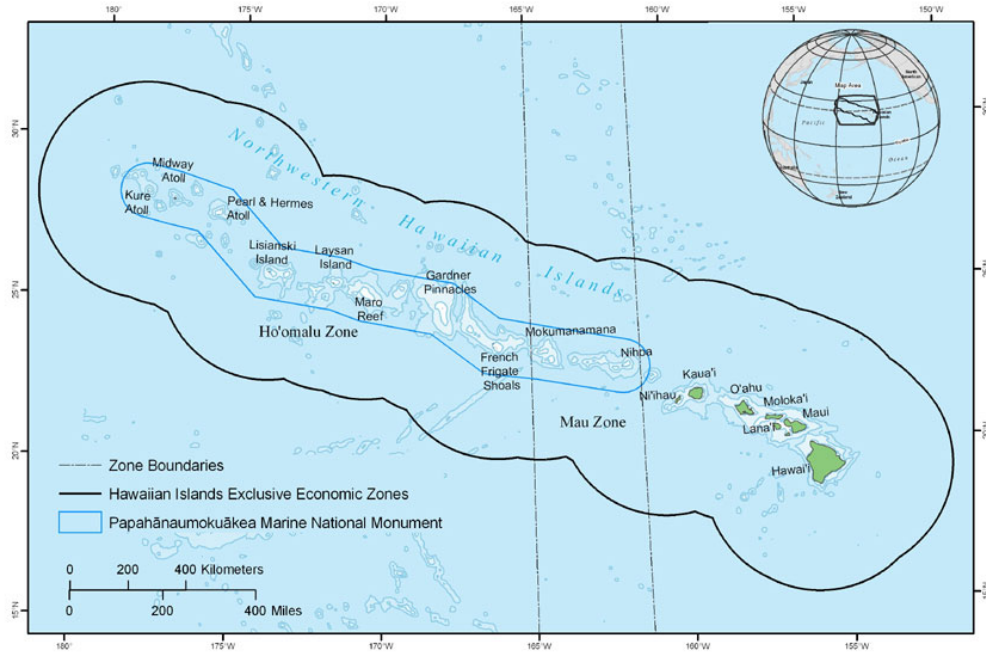
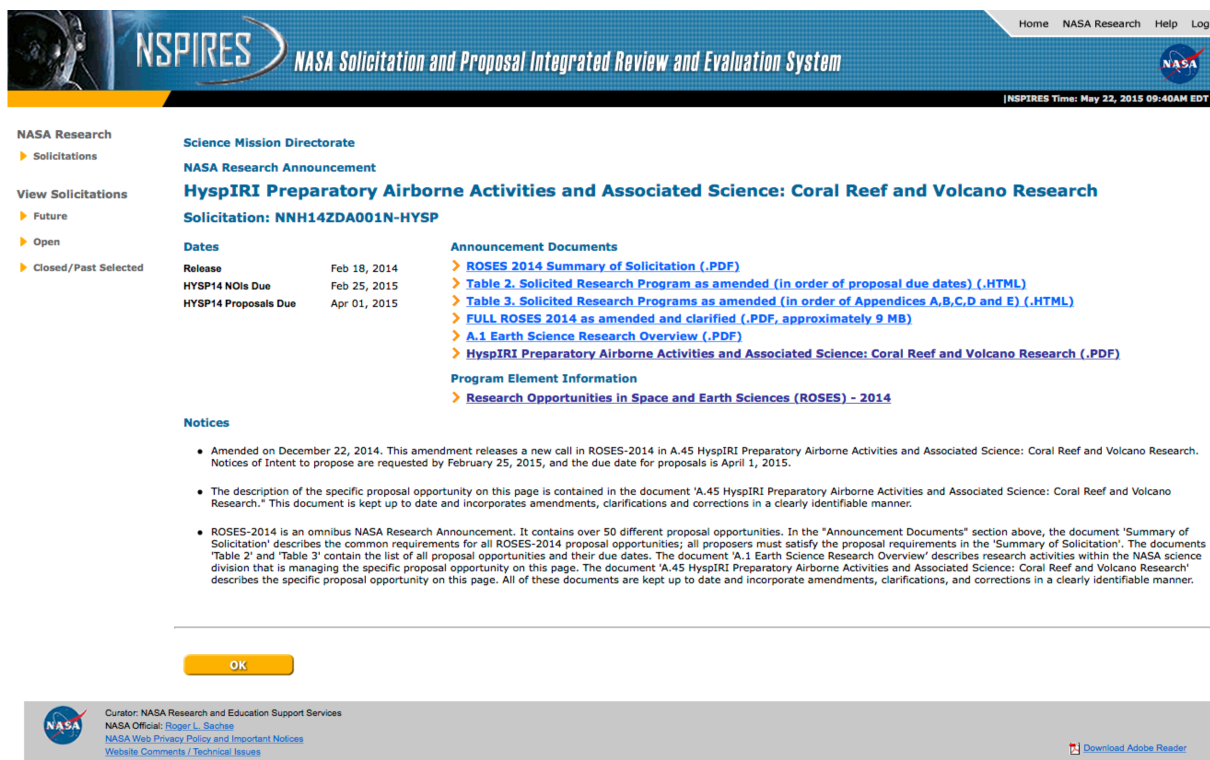
2016 HyspIRI Preparatory Airborne Campaign to Hawaii for Coral Reefs and Volcanoes





NSPIRES NASA Solicitation and Proposal Integrated Review and Evaluation System

Home NASA Research Help Login

|NSPIRES Time: May 22, 2015 09:40AM EDT

NASA Research
- Solicitations

View Solicitations
- Future
- Open
- Closed/Past Selected

Science Mission Directorate

NASA Research Announcement

HyspIRI Preparatory Airborne Activities and Associated Science: Coral Reef and Volcano Research

Solicitation: NNH14ZDA001N-HYSP

Dates

Release	Feb 18, 2014
HYSP14 NOIs Due	Feb 25, 2015
HYSP14 Proposals Due	Apr 01, 2015

Announcement Documents
- ROSES 2014 Summary of Solicitation (.PDF)
- Table 2. Solicited Research Program as amended (in order of proposal due dates) (.HTML)
- Table 3. Solicited Research Programs as amended (in order of Appendices A,B,C,D and E) (.HTML)
- FULL ROSES 2014 as amended and clarified (.PDF, approximately 9 MB)
- A.1 Earth Science Research Overview (.PDF)
- HyspIRI Preparatory Airborne Activities and Associated Science: Coral Reef and Volcano Research (.PDF)

Program Element Information
- Research Opportunities in Space and Earth Sciences (ROSES) - 2014

Notices

- Amended on December 22, 2014. This amendment releases a new call in ROSES-2014 in A.45 HyspIRI Preparatory Airborne Activities and Associated Science: Coral Reef and Volcano Research. Notices of Intent to propose are requested by February 25, 2015, and the due date for proposals is April 1, 2015.
- The description of the specific proposal opportunity on this page is contained in the document 'A.45 HyspIRI Preparatory Airborne Activities and Associated Science: Coral Reef and Volcano Research." This document is kept up to date and incorporates amendments, clarifications and corrections in a clearly identifiable manner.
- ROSES-2014 is an omnibus NASA Research Announcement. It contains over 50 different proposal opportunities. In the "Announcement Documents" section above, the document 'Summary of Solicitation' describes the common requirements for all ROSES-2014 proposal opportunities; all proposers must satisfy the proposal requirements in the 'Summary of Solicitation'. The documents 'Table 2' and 'Table 3' contain the list of all proposal opportunities and their due dates. The document 'A.1 Earth Science Research Overview' describes research activities within the NASA science division that is managing the specific proposal opportunity on this page. The document 'A.45 HyspIRI Preparatory Airborne Activities and Associated Science: Coral Reef and Volcano Research' describes the specific proposal opportunity on this page. All of these documents are kept up to date and incorporate amendments, clarifications, and corrections in a clearly identifiable manner.

OK

Curator: NASA Research and Education Support Services
NASA Official: Roger L. Sachse
NASA Web Privacy Policy and Important Notices
Website Comments / Technical Issues

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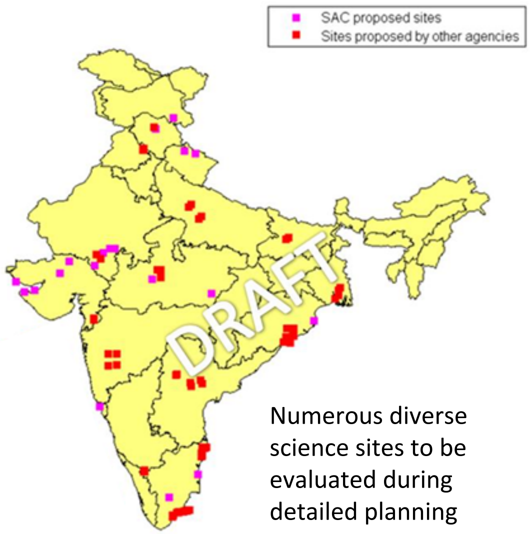
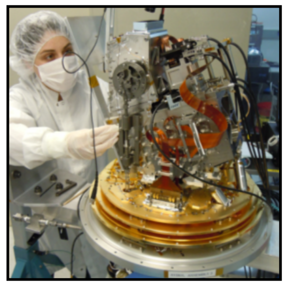
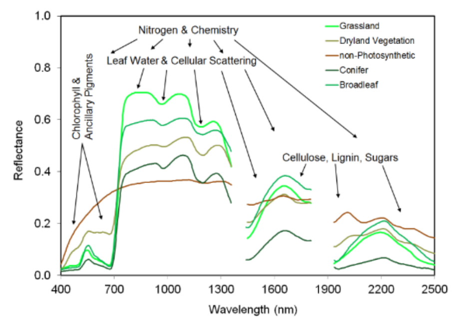
W. Turner

AVIRIS-NG NASA and ISRO Airborne Campaign in India



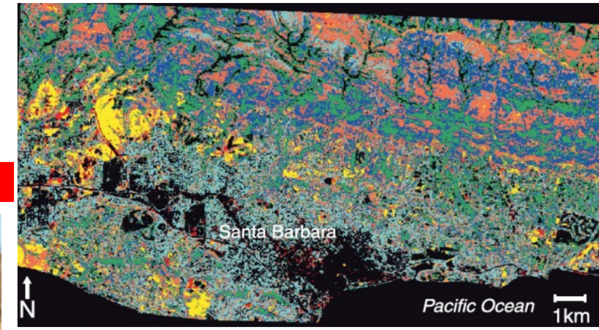
Numerous diverse science sites to be evaluated during detailed planning



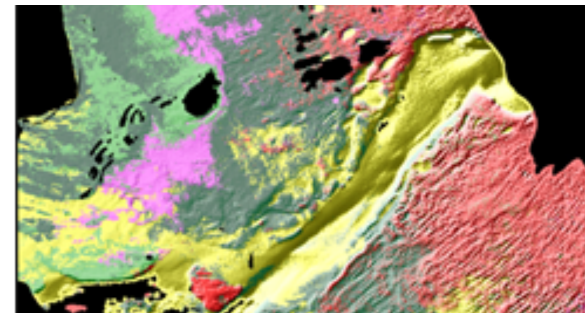


- This airborne campaign would provide the <u>first of their kind</u> high fidelity imaging spectroscopy measurement of a diverse set of <u>Asian environments</u> for NASA
- This campaign would enable new scientific and applications research in these unique environments
  - Natural ecosystems (Humid, Temperate, Dry)
  - Water resources: Snow and Ice (Dust and black carbon)
  - Geology and Natural Hazards (floods, droughts, fire …)
  - Coastal and inland waters, Coral reefs
  - Agricultural lands and Urban areas
- This campaign builds upon the current plan for AVIRIS-NG to fly on a US B-200 aircraft in 2015 (and ER-2 in 2016)

Ecosystem and Agriculture

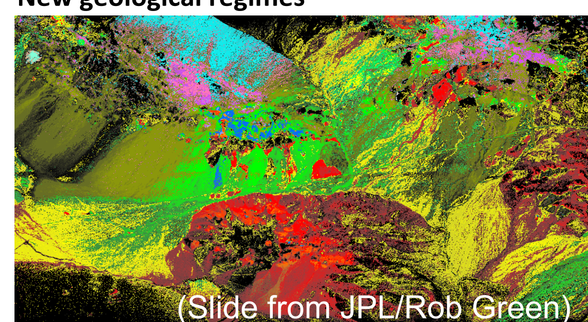


Asian Coastal Waters & Coral



Dust and Black Carbon on Snow & Ice

New geological regimes



W. Turner

SLI in FY16 President's Budget Submit

- A multi-component program, with the essential investments in technology and observational innovation to ensure a world class, sustainable, and responsible land imaging program through 2035:

1. TIR-FF (Class D Thermal Infrared Free Flyer) to launch ASAP (no later than 2019) and to fly in constellation with a reflective band imager like OLI on L-8
   - Low-cost mitigation against an early loss of the Landsat 8 Class C TIRS, while demonstrating feasibility of constellation flying for land imaging

2. Landsat 9 (Class B upgraded rebuild of Landsat 8) to launch in 2023
   - Low programmatic risk implementation of a proven system with upgrades to bring the whole system to Class B

3. Land Imaging Technology and Systems Innovation
   - Hardware, operations and data management/processing investments to reduce risk in next generation missions.

4. Landsat 10
   - Mission definition to be informed by the Technology investments, leading to key mission configuration/architecture decisions by the end of the decade

NASA Budget for	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020
Sustainable Land Imaging	$30,000	$64,100	$78,900	$134,600	$174,400	$179,900	$147,300

HyspIRI Progress and Plans

FY14 Results

- Refined instrument concept approaches for Class D P/L for the ISS ✓
  - Compact VSWIR Dyson spectrometer
  - Investigated smallsat compatibility
  - ECOSTRESS EVI-2 selection leveraged (PHyTIR)
- Demonstrated VSWIR & TIR Level 1 & Level 2 algorithms for large volumes of data over diverse environments ✓
- Demonstrated convolution of airborne VSWIR data to Landsat bands and conducted underflights for cal/val investigations ✓
- IPEX CubeSat, funded by ESTO ATI, successfully flight validated IPM autonomous product generation technology ✓

FY15 Objectives

- Continue to conduct HyspIRI data product generation and benchmarking with airborne data
- Carry out additional instrument mission trade studies to provide lower cost and more adaptable instrument and/or mission approaches
- Develop a plan for utilizing the ECOSTRESS mission results for HyspIRI risk reduction
- Continue to engage potential international and domestic partners in addressing opportunities to lower the cost of a potential mission while maintaining Level 1 mission requirements

http://hyspiri.jpl.nasa.gov/

HyspIRI Thermal Sensor & ECOSTRESS

Simon Hook

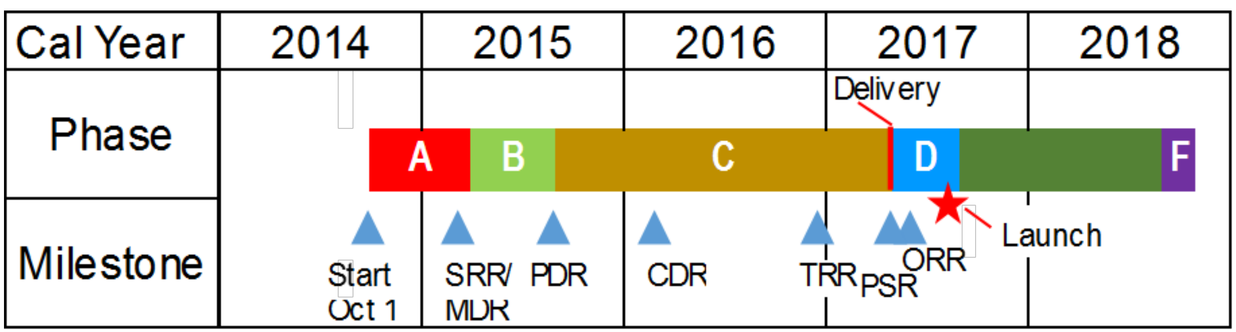
ECOSTRESS is an Earth Venture Instrument-2 on the ISS

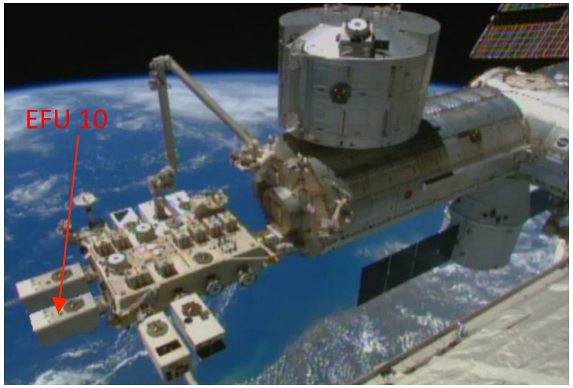
Primary Science Objectives

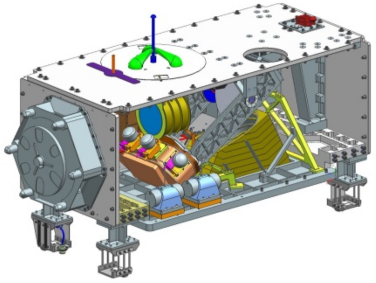
- Identify critical thresholds of water use and water stress in key climate-sensitive biomes
- Detect the timing, location, and predictive factors leading to plant water uptake decline and cessation over the diurnal cycle
- Measure agricultural water consumptive use over the contiguous United States (CONUS) at spatiotemporal scales applicable to improve drought estimation accuracy

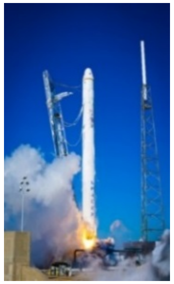
Features:

- \$29.9M RY Cat 3/Risk class D per NPR 7120.5E/ NPR 8705.4
- 8–12.5 µm Radiometer with a 400km swath, ~60-m resolution
- Measure brightness temperatures of Earth at selected location
- May 2017 Payload delivery date, Ready for launch August 2017
- Deployed on the ISS on JEM-EFU 10
- Operational life: 1 year after 30 days on-orbit checkout









Hook, et al.

Summary

- The ECOSTRESS mission will help answer three key science questions:
  - How is the terrestrial biosphere responding to changes in water availability?
  - How do changes in diurnal vegetation water stress impact the global carbon cycle?
  - Can agricultural vulnerability be reduced through advanced monitoring of agricultural water consumptive use and improved drought estimation?
- ECOSTRESS has a clearly defined set of data products and mature algorithms
- Opportunity for creating HyspIRI-like datasets using ECOSTRESS, HyTES and MASTER

ECOSTRESS will launch in 2017 and provide highest spatial resolution thermal infrared data ever from the International Space Station. The experiment is focused on plants but data useful for many applications

EO-1: Request for Mission Extension

Elizabeth M. Middleton
EO-1 Mission Scientist 2007- present
Biospheric Sciences Laboratory, NASA GSFC

Daniel J. Mandl
EO-1 Mission Manager 2000-present
Software Systems Engineering Branch, NASA GSFC

Stuart W. Frye
Lawrence Ong
Stephen G. Ungar
Petya E. Campbell
K. Fred Huemmrich
David R. Landis

March 23, 2015

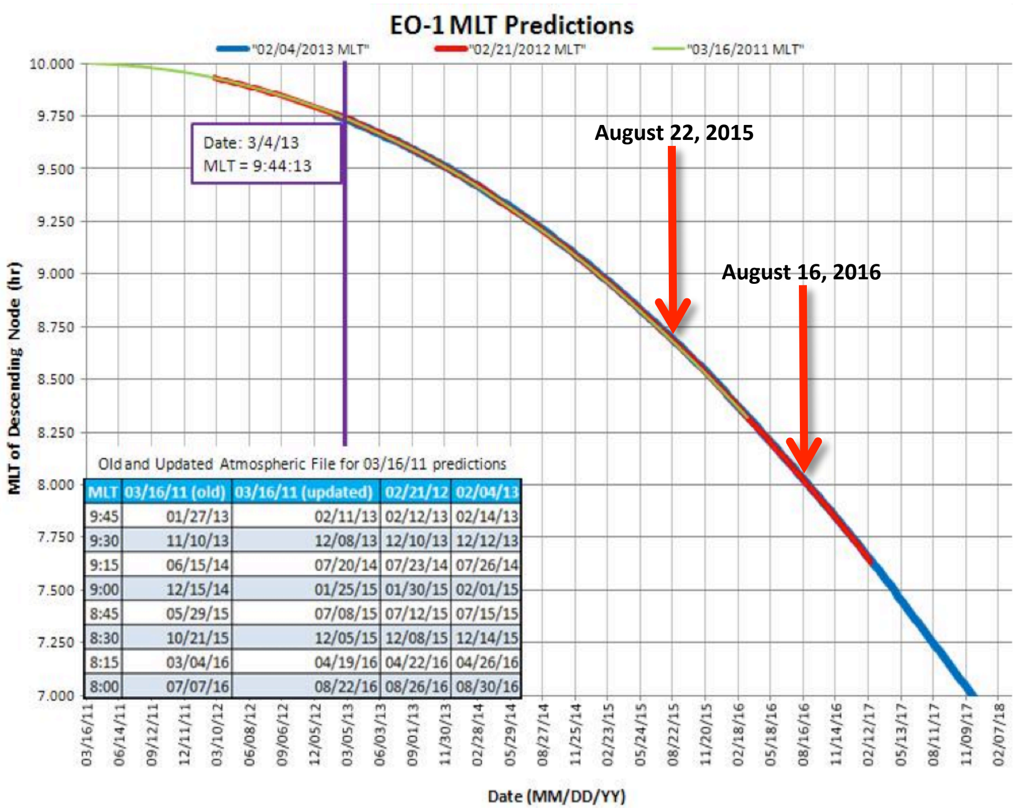
EO-1 Mission Extension

We request an extension of EO-1 because:

- In spite of orbital changes, EO-1 provides unique and valuable data to the science & applications communities and supports SLI, HyspIRI, & future mission development.
  - Rapid response
  - Hyperspectral imagery
- The risks are low
- The costs are low

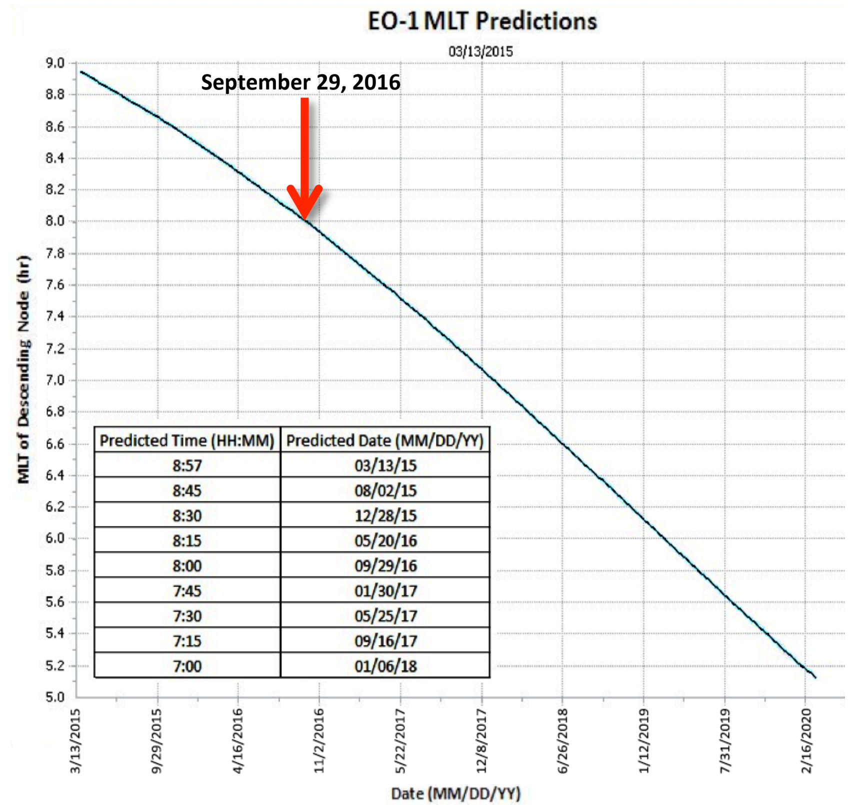
Comparison of March 2013 Senior Review MLT Projections with March 2015

Shows orbital projections have been consistent and that earlier predictions were too conservative.



MLT	03/16/11 (old)	03/16/11 (updated)	02/21/12	02/04/13
9:45	01/27/13	02/11/13	02/12/13	02/14/13
9:30	11/10/13	12/08/13	12/10/13	12/12/13
9:15	06/15/14	07/20/14	07/23/14	07/26/14
9:00	12/15/14	01/25/15	01/30/15	02/01/15
8:45	05/29/15	07/08/15	07/12/15	07/15/15
8:30	10/21/15	12/05/15	12/08/15	12/14/15
8:15	03/04/16	04/19/16	04/22/16	04/26/16
8:00	07/07/16	08/22/16	08/26/16	08/30/16

Orbital Projection from March 2013 Senior Review Proposal



Predicted Time (HH:MM)	Predicted Date (MM/DD/YY)
8:57	03/13/15
8:45	08/02/15
8:30	12/28/15
8:15	05/20/16
8:00	09/29/16
7:45	01/30/17
7:30	05/25/17
7:15	09/16/17
7:00	01/06/18

Orbital Projection from March 2015 Latest Calculations

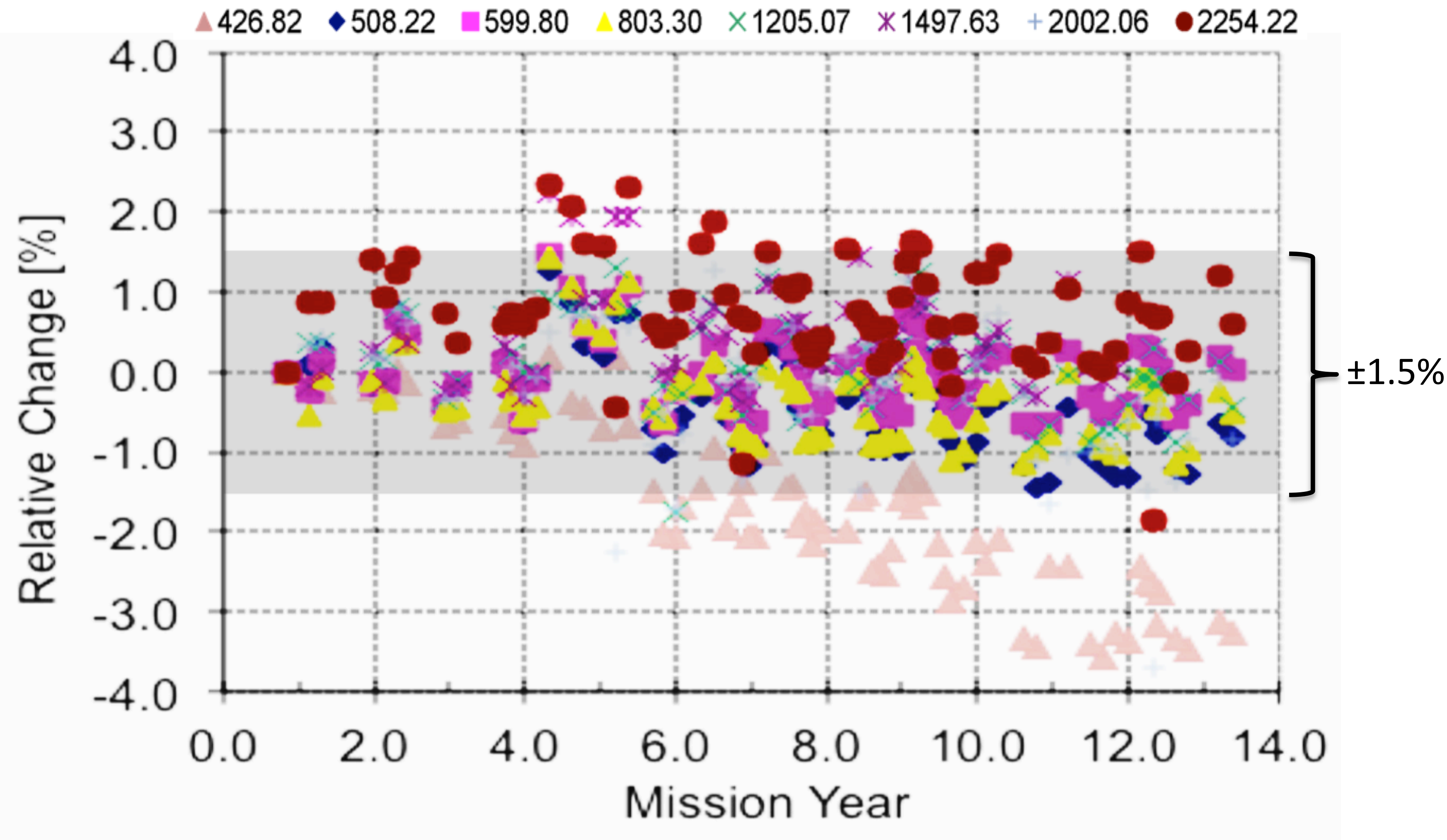
This EO-1 MLT and SMA analysis was independently verified by the Terra, Aqua, Aura Flight Dynamics team.

Overview: What EO-1 Offers that no other NASA Mission Provides

EO-1 is a fundamentally unique NASA asset, providing capabilities not available with any existing or currently planned space platform.

- **EO-1 is a highly maneuverable *testbed* asset which can be (and has been) assigned a variety of high priority tasks of critical interest to the NASA Earth Science Division.**
- **Hyperion is the only spaceborne satellite imaging spectrometer (IS), uniquely providing a 14.5 year archive. Hyperion data continue to be used as a source for understanding how spectroradiometric properties relate to the physical state (and disturbances) of the Earth's surface.**
- **Hyperion paves the way for future IS missions, providing unprecedented quantitative assessments of terrestrial and aquatic ecosystems.**
- **Technology Pathfinder, such as:**
  - **Onboard autonomy software (Autonomous ScienceCraft Experiment – JPL)**
  - **Onboard intelligent diagnostic software (Livingstone – Ames)**
  - **IP for space (Delay Tolerant Network – GSFC)**
  - **Onboard cloud detection (Lincoln Lab – GSFC & JPL)**
  - **SensorWeb/GeoSocial API for ease of tasking satellites, discovery/delivery of satellite data products (GSFC, JPL, International Disaster community)**
  - **Intelligent Payload Module (IPM) for low latency HyspIRI products (GSFC)**

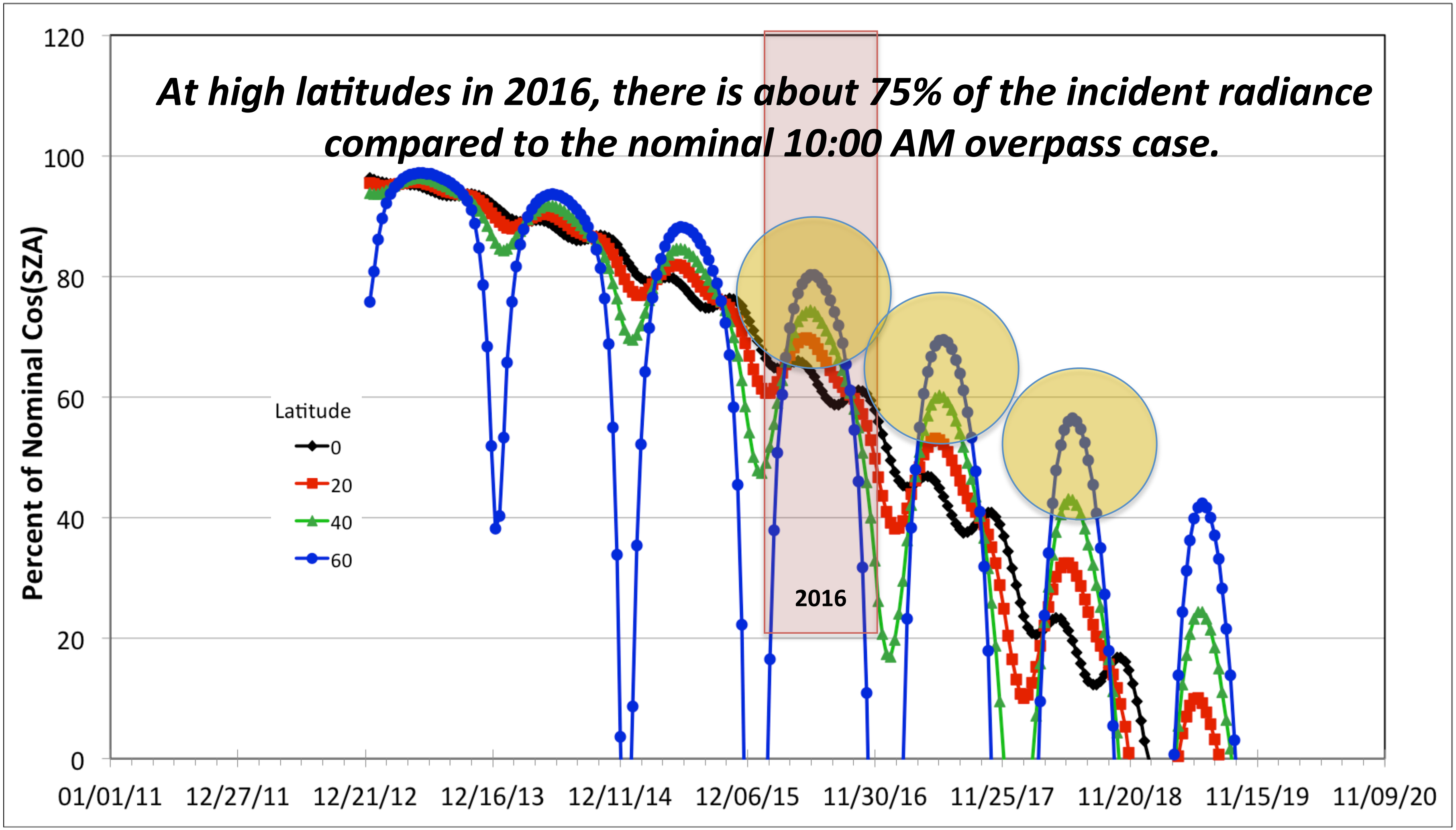
We can continue to use EO-1 productively because of sensor stability… *Hyperion Stability*



Middleton, et al.

Fraction of Cos(SZA) Compared to Nominal at EO-1 Overpass

This fraction is the surface energy compared to the nominal surface energy for a given time and location.



Middleton, et al.

Benefits from Extending the EO-1 Mission

- **Satellite Community**
  - **Prototyping and cal/val for NASA and NOAA**
  - **CEOS/WGCV - characterization of semi-invariant sites**
  - **Prototyping and cal/val for HyspIRI, ESA/SENTINEL-2, DLR/EnMAP and IEEE/ISIS**
- **Terrestrial Ecology and Land Cover Research**
  - **Product cal/val: LCLUC, Carbon Cycle, CEOS/LVP, ABoVE, Geology and Coastal/Aquatic characterization**
- **Disaster Management Community**
  - **Domestic (US Forest Service, NOAA, USGS etc.)**
  - **International (UN, World Bank)**
- **Data Continuity for SLI and CEOS via EO-1 Lunar Lab**
  - **If EO-1 Lunar Lab is in operation to overlap CLARREO Pathfinder (2019), the coincident lunar measurements will allow the entire EO-1 ALI and Hyperion archive to be put on the CLARREO radiometric scale, along with the other sensors that have and will image the moon.**

Sentinel-2 / Landsat Collaboration

Jeff Masek, NASA GSFC
June 3, 2015 / HysPIRI Workshop, GSFC

ESA Sentinel-2 mission

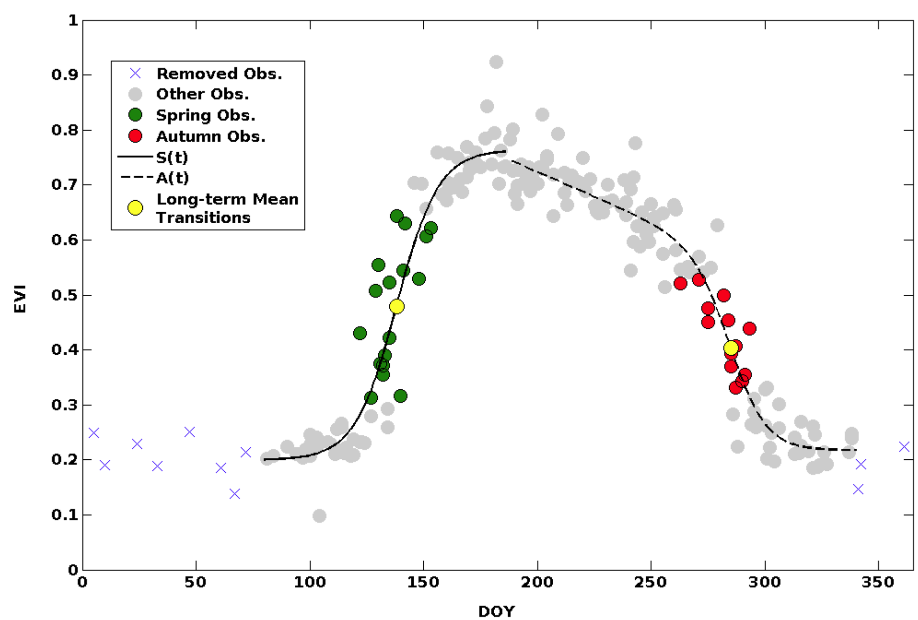
- Sentinel-2 is the ESA/Copernicus "Landsat-like" observatory
  - Two simultaneous platforms (S2a, S2b) provide 5-day global land coverage from MSI (Mult-Spectral Imager) instrument
  - S2a launch ~June 23, 2015; S2b ~summer 2016
  - Similar spectral/spatial coverage as Landsat OLI
    - More spectral bands (e.g. red edge); somewhat finer (10-20m) resolution
  - Free and open data policy (but US users may not have high priority in queue)

Parameter	MSI	OLI
Swath	290	185
Repeat Cycle	10 (5)	16 (8)
Field of View	20.6°	15°
Equatorial Crossing	10:30 AM	10:13 AM
Spectral Coverage	440-2300 nm	440-2300 nm
Spectral Bands	13	9
IFOV	4 VNIR Bands @ 10 m 6 Bands @ 20 m 3 Atmospheric Bands @ 60 m	8 Bands @ 30 m 1 Pan Band @ 15 m
Data Quantization	12 bits	12 bits
Saturation Radiances	~100% diffuse solar	~100% diffuse solar

Masek, et al.

Science Rationale

- Since the opening of the USGS Landsat archive, there has been increased science interest in ***intra-annual*** time series applications at ~30 m resolution
  - Agricultural monitoring (e.g. GEO-GLAM)
  - Patch-scale vegetation biophysics (LAI, fPAR, productivity)
  - Phenology and climate linkages
  - WELD data products
- Current systems struggle to meet these needs in terms of resolution (MODIS) or frequency (Landsat)
- Combining Sentinel-2 and Landsat-8 data streams offers **near-daily, global 30m coverage**

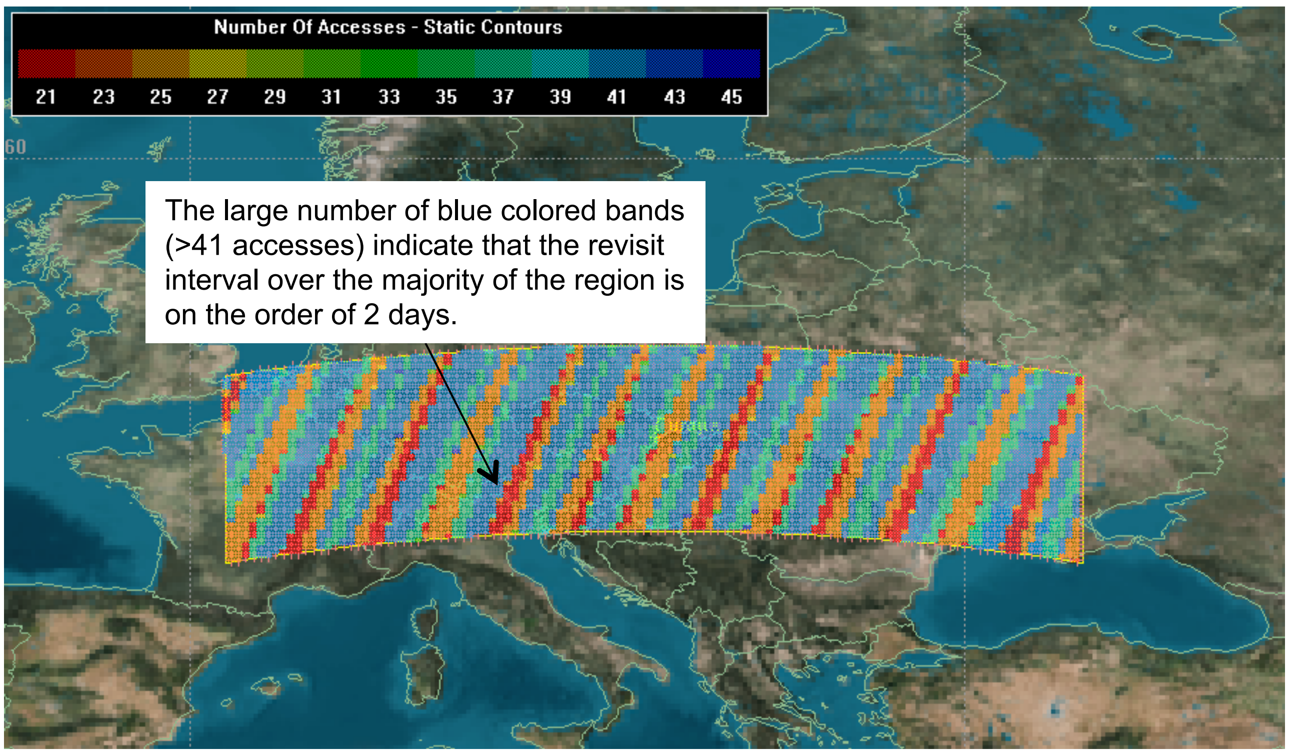


Example: New England forest phenology from multi-annual Landsat observations (Melaas et al., 2013, RSE)

Masek, et al.

Sentinel-2 and Landsat Synergy

- Sentinel-2: ESA "Landsat-like" system with 10-day repeat per platform
- 2 platforms (S2a, S2b) give 5-day repeat
- 2-4 day repeat when combined with Landsat-8



Number of times Landsat-8 and the Sentinel 2 satellites accessed areas on the ground over an 80 day period of time.

- 21 accesses indicates a maximum revisit interval of ~3 days 19 hours

- 46 accesses indicates a minimum revisit interval of ~1 day 18 hours

Courtesy Brian Killough, LARC

Masek, et al.

Intelligent Payload Module Update

Dan Mandl

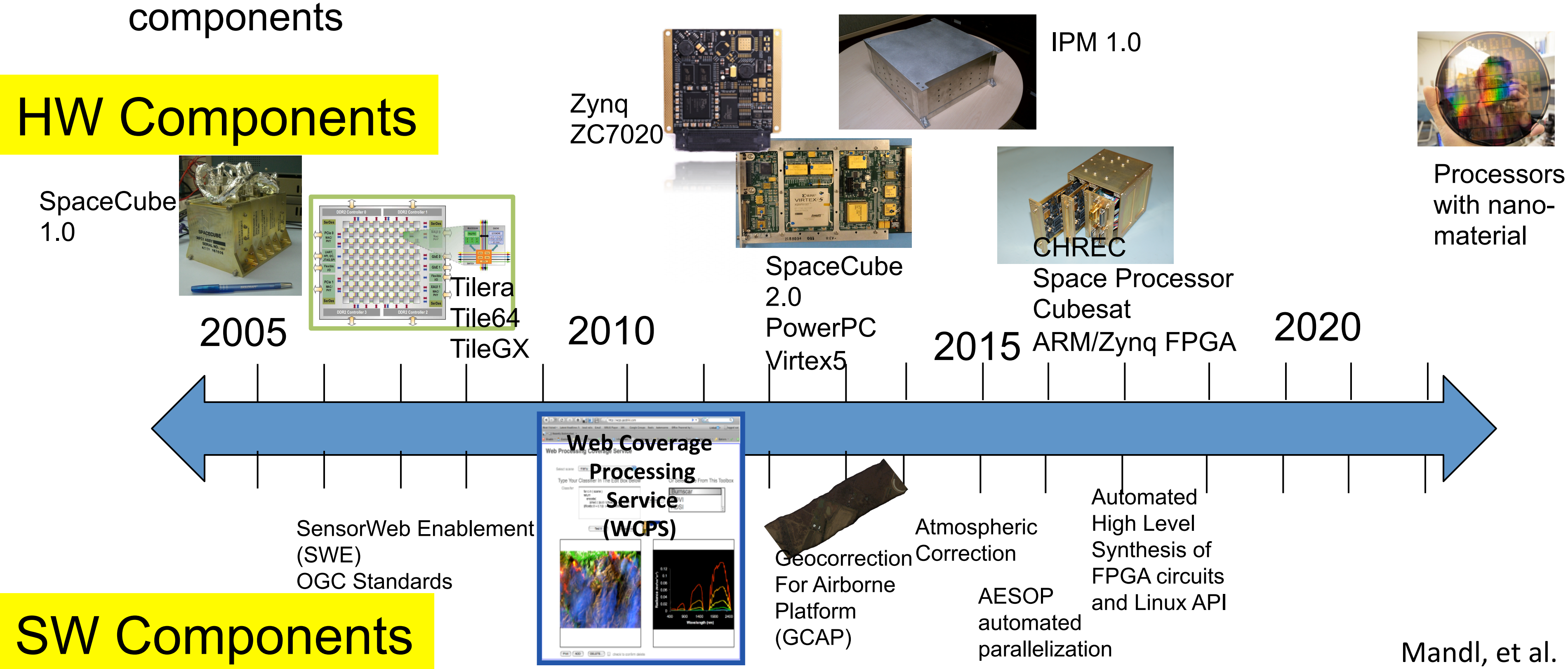
HyspIRI Symposium
Onboard Processing and Efficient Data Product Distribution Session
June 3, 2015

Key Intelligent Payload Module (IPM) Functionality

- Secondary onboard science data processor
- High performance onboard processing (radiation hardened/ tolerant) that can handle 930 Mbps input instrument data rate
  - Multicore processors
  - Field Programmable Gate Array (FPGA)
- Rapid access to real time subsets of sensor data for low latency users
- Rapid access to real time or near real time science data products for low latency users
- Rapid customization and integration of onboard algorithms
- Utilize industry standard formats;
- Minimize mass, volume, and power;
- Provide user extensible image processing toolkit (WCPS);
- Support a heterogeneous series of orbital, sub-orbital and *in situ* platforms via SensorWeb coordination.

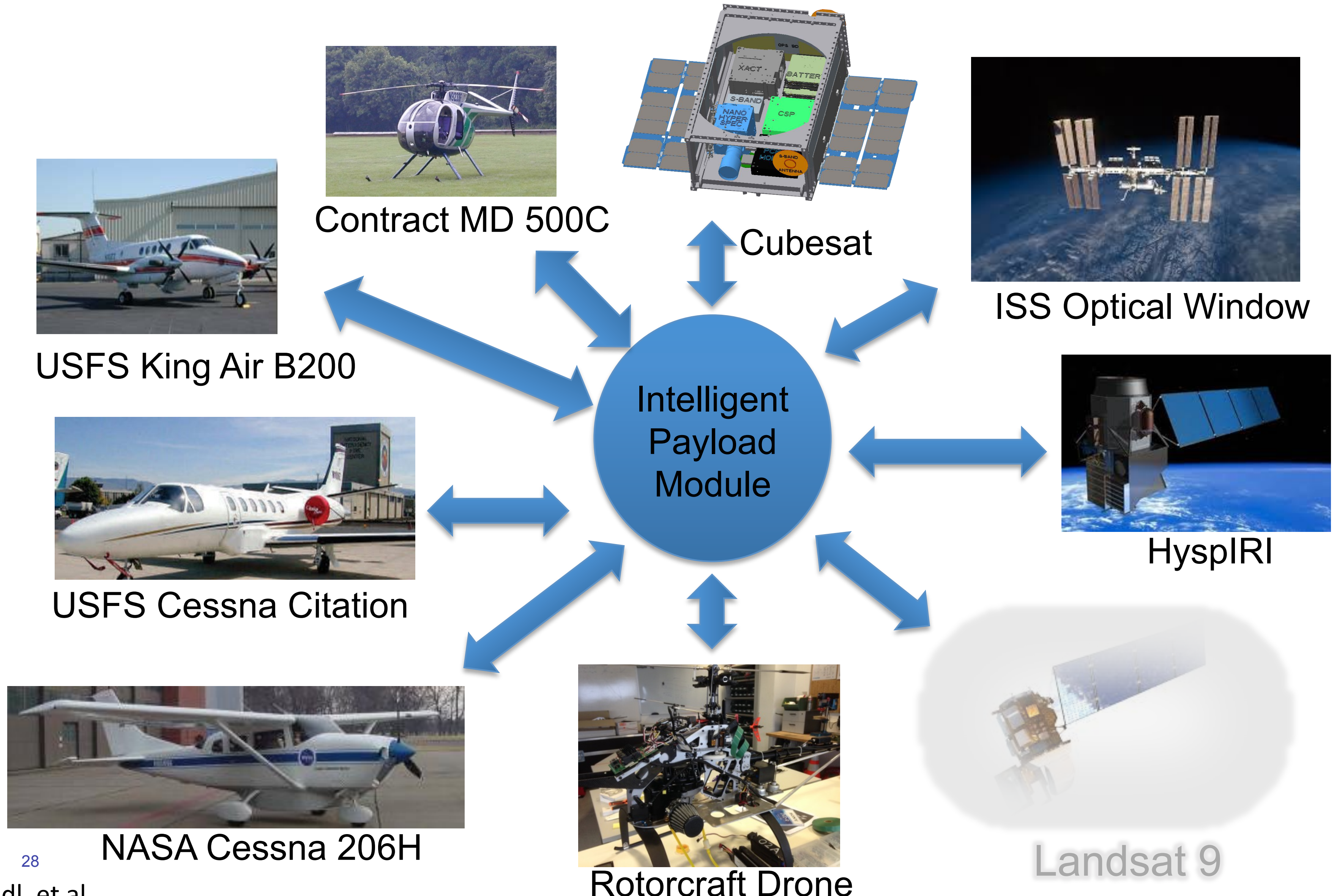
IPM as an Evolving Platform Integrating HW and SW Components

- IPM is a platform which integrates an evolving set of hardware and software components



IPM Weight	5-20 lbs		<1 lb
IPM Power	20 – 80 watts	<10 watts	<2-3 watts
IPM Clock	100 Mhz – 800 Mhz		>300 Mhz
Data Throughput	50 kbps – 1 Gbps		>10 Gbps

IPM: Broad Range of Supported Platforms



Mandl, et al.

HyspIRI

Estimation of GPP with $fAPAR_{chl}$ and LAI_{chl}

Qingyuan Zhang[1,2]
Alexei I. Lyapustin[3]
Fanwei Zeng[1,5]
William P. Kustas[7]
Elizabeth M. Middleton[1]
Tian Yao[1,2]
Yujie Wang[1,4]
Jiangfeng Wei[6]
Feng Gao[7]
Karl F. Huemmrich[1,4]

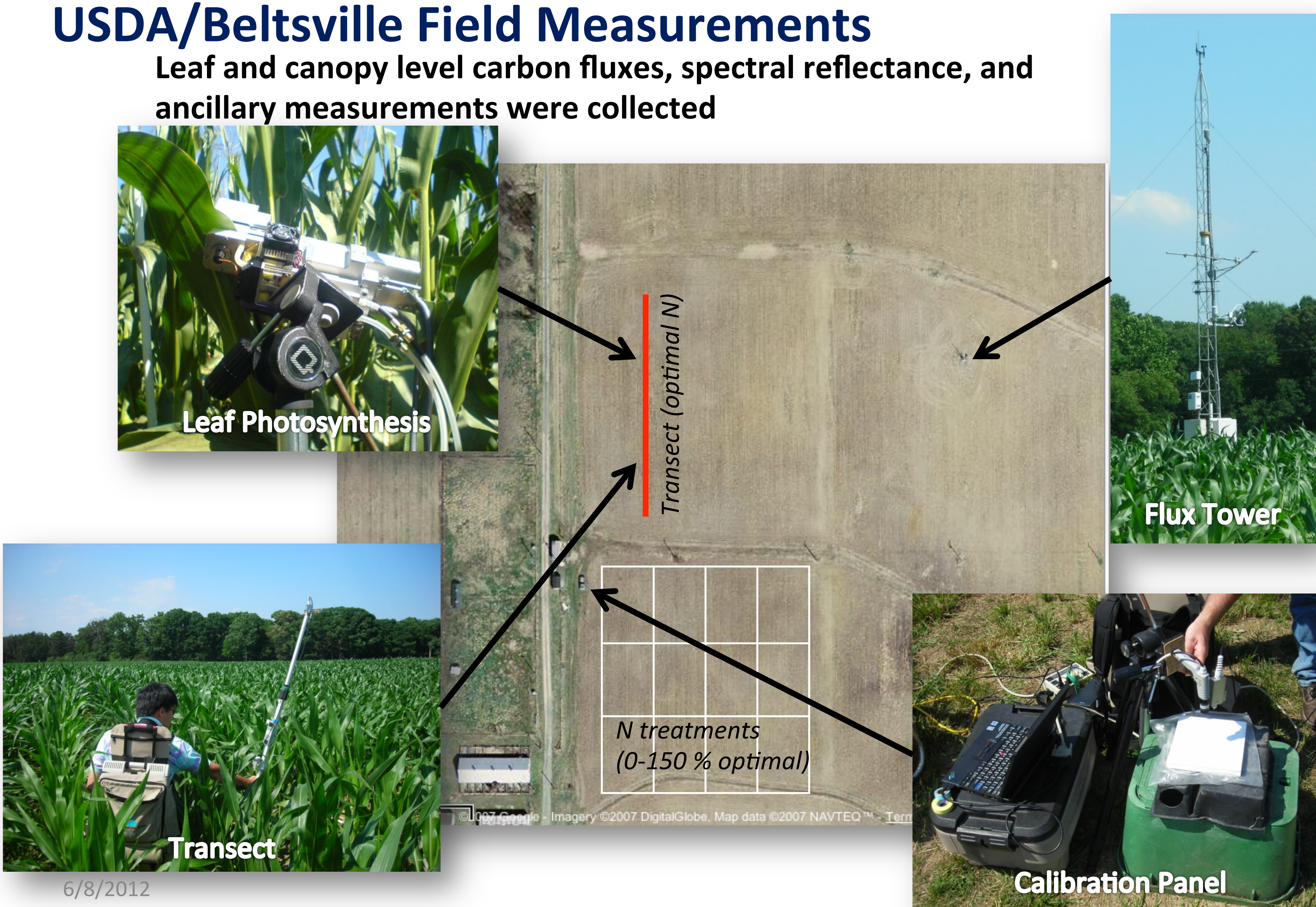
[1]NASA/GSFC, code 618; [2]USRA; [3]NASA/GSFC, code 613;
[4]UMBC; [5]SSAI; [6]University of Texas at Austin; [7]USDA

HyspIRI Mission and Product Symposium
NASA Goddard Space Flight Center (GSFC), June 3-4, 2015

Integration of $fAPAR_{chl}$ and PRI to estimate GPP

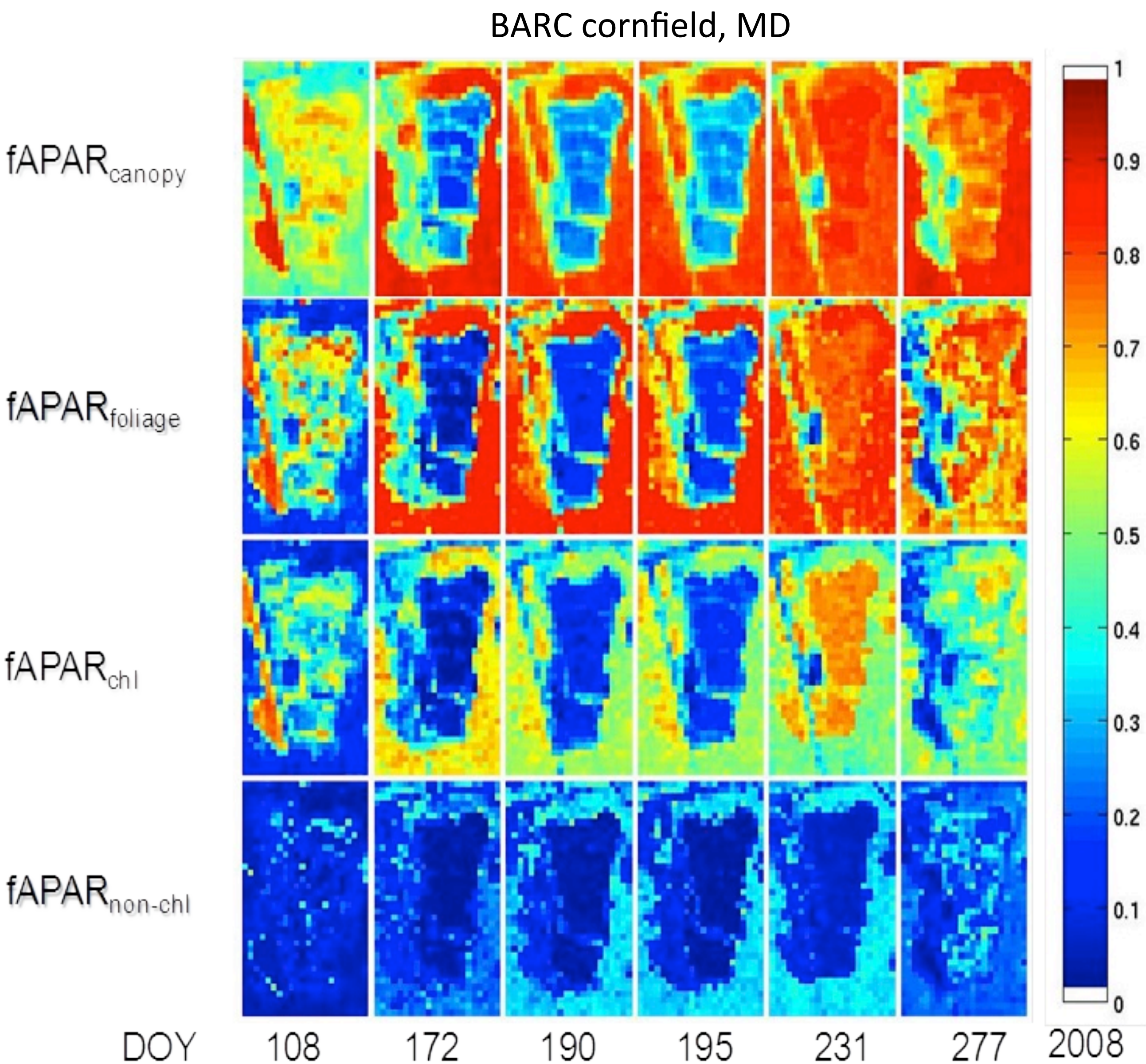
USDA/Beltsville Field Measurements

Leaf and canopy level carbon fluxes, spectral reflectance, and ancillary measurements were collected



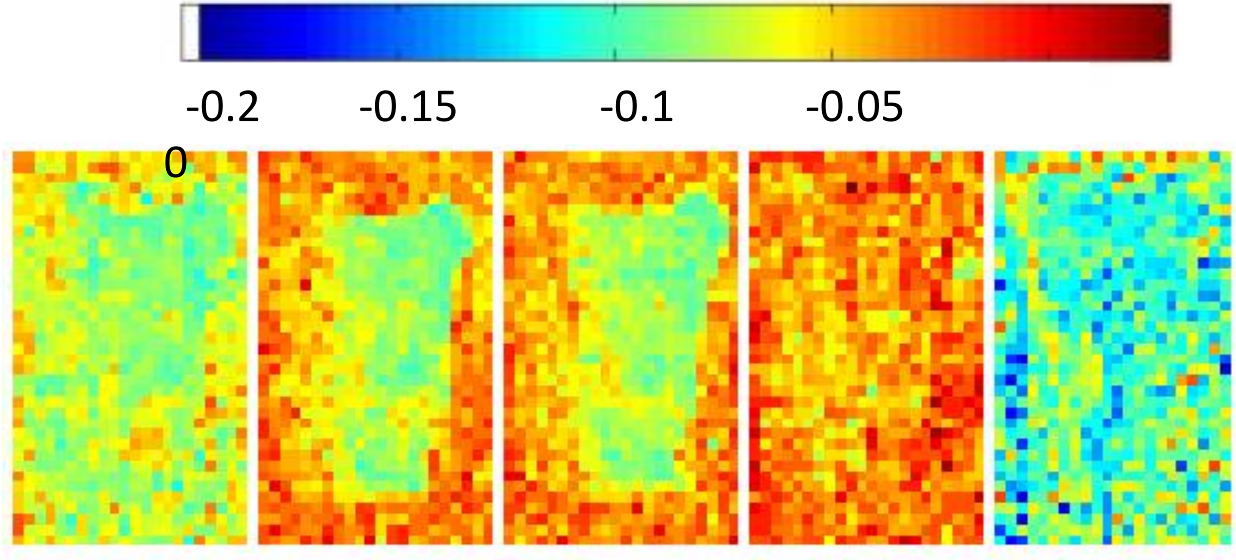
Zhang, et al.

Integration of $fAPAR_{chl}$ and PRI to estimate GPP

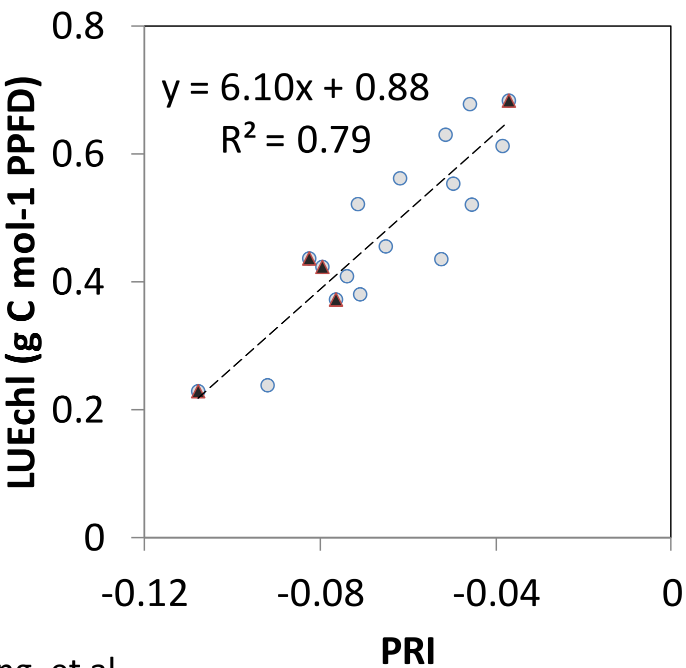


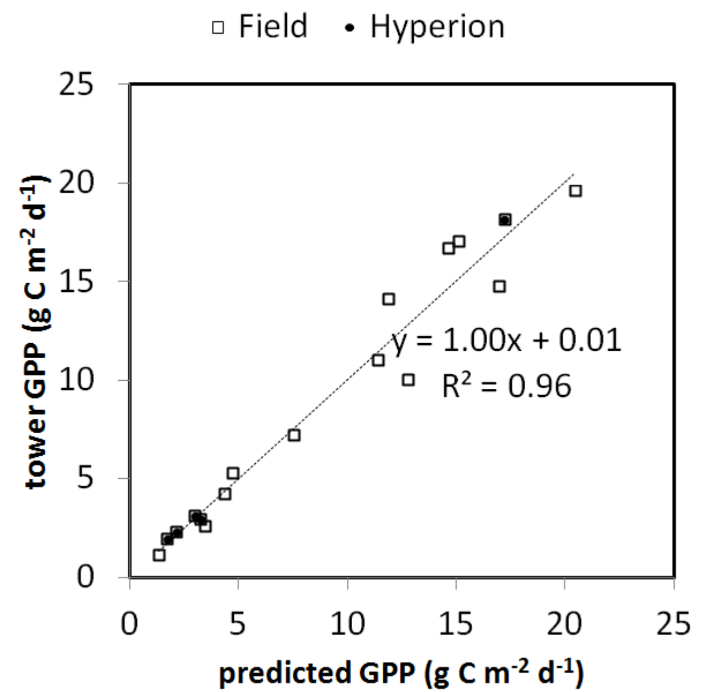
Zhang, et al.

PRI



DOY 172 190 195 231 277 in 2008





Zhang, et al.

FLEX-US 2013 Airborne Campaign Summary

Collaboration between NASA, ESA, and the FLuorescence Explorer Mission

Lawrence Corp

Science Systems & Applications Inc., Lanham, MD

Elizabeth Middleton & Bruce Cook

Biospheric Sciences Branch, NASA/GSFC, Greenbelt MD

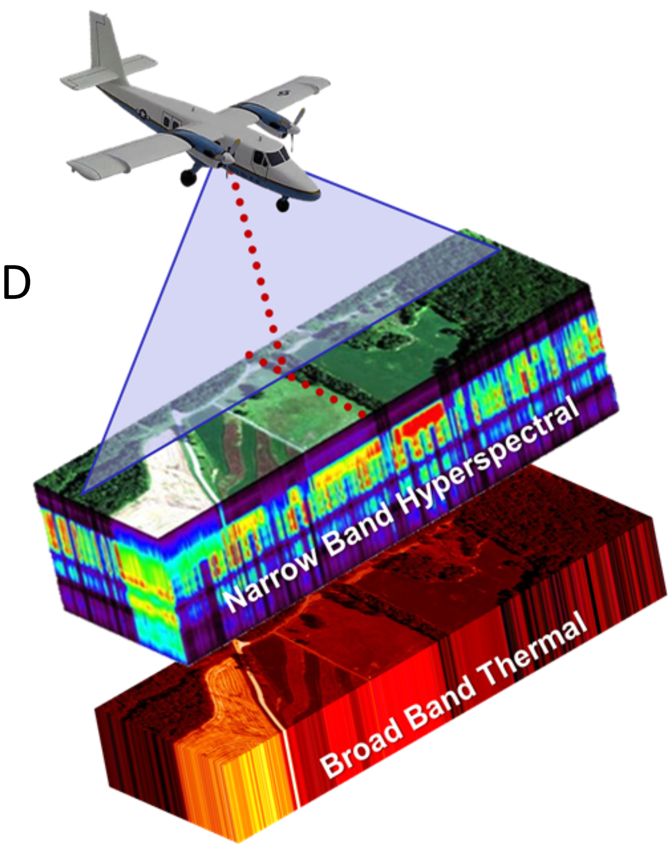
Petya Campbell & Fred Huemmrich

Joint Center for Earth System Technology (JCET),

University of Maryland Baltimore County

Uwe Rasher & Franscisco Pinto

Forschungszentrum Jülich, Germany



Goddard Space Flight Center

To understand and protect our home planet, to explore the Universe and search for life, to inspire the next generation of explorers...as only NASA can.

SSAI

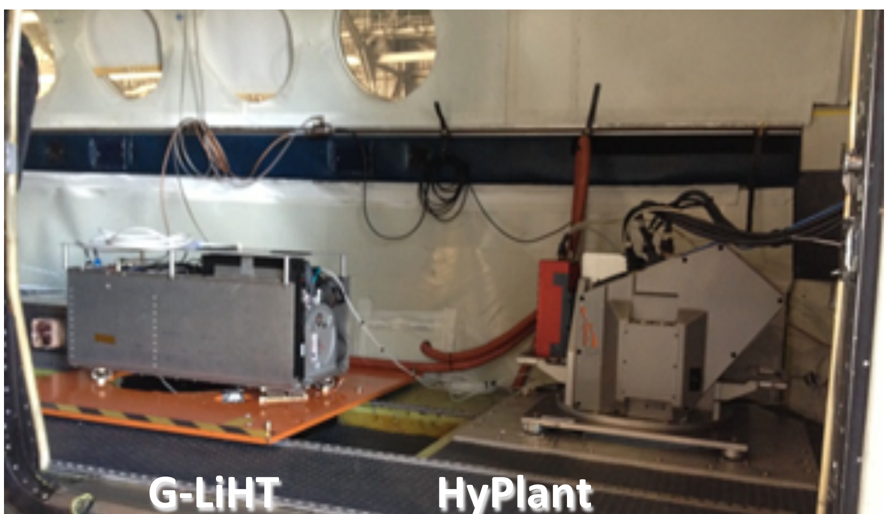
FLEX-US 2013 Airborne Campaign

Collaboration between NASA, ESA, and the FLuorescence Explorer Mission

Objectives:

- **Successfully co-manifest a comprehensive set airborne instruments on the NASA LARC KingAir.**
- **Conduct science flights, obtaining morning, mid-day, and afternoon datasets for two unique ecosystems in North Carolina.**

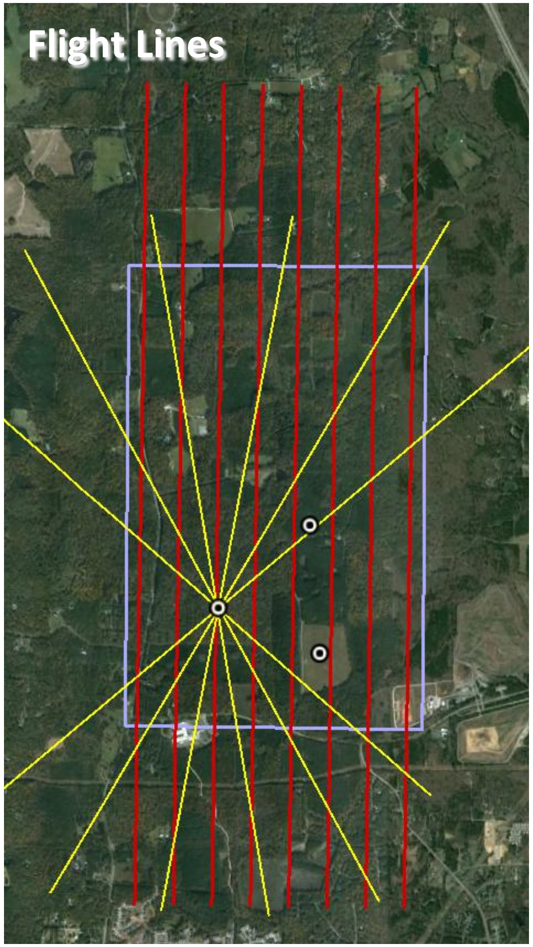
G-LiHT & HyPlant Flight Testing NASA LARC USA



Campaign retreat Monschau Germany

Corp, et al.

FLEX-US 2013 Airborne Campaign



Duke University Research Forest

- Long history of manipulative experiments.
- Mixed deciduous & pine forests.
- Active DK3 micro-meteorological tower.
- Rolling terrain 100 to 200 m above MSL
- Extensive ground survey data available.

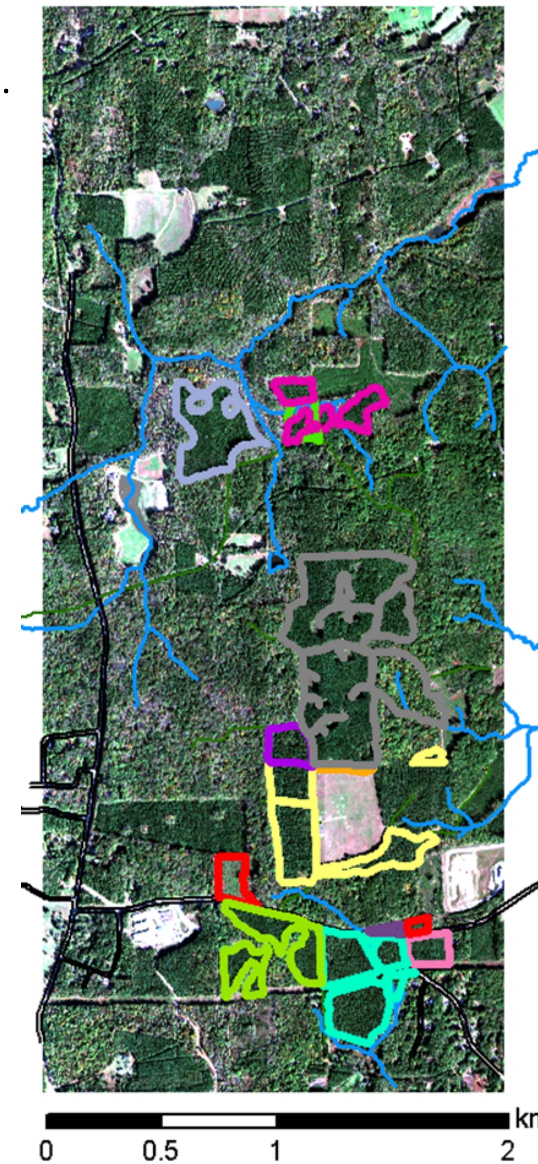
Study Area

Cal/Val Sites

Flight Lines

Solar Lines

G-LiHT RGB Mosaic (2m)



Loblolly Pine Planting Year

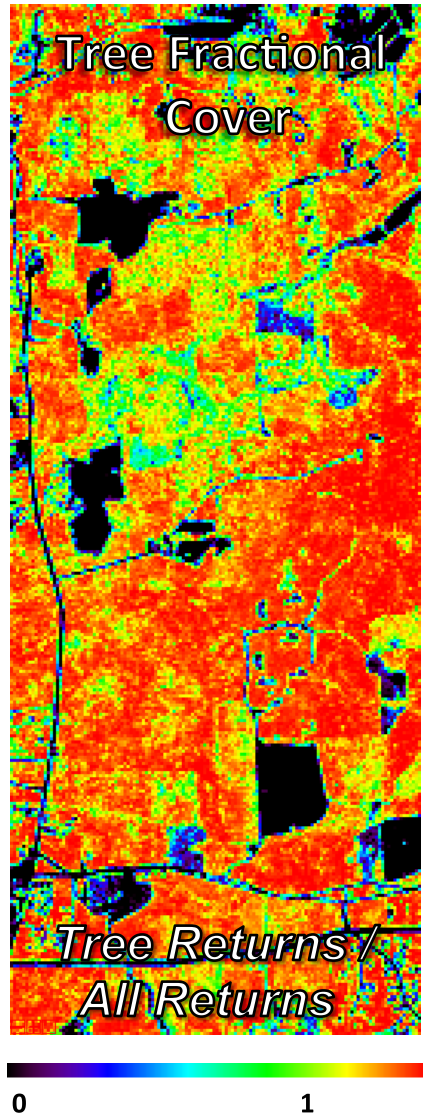
1948
1950
1951
1981
1982
1983
1985
1987
1993
2001
2002
2005

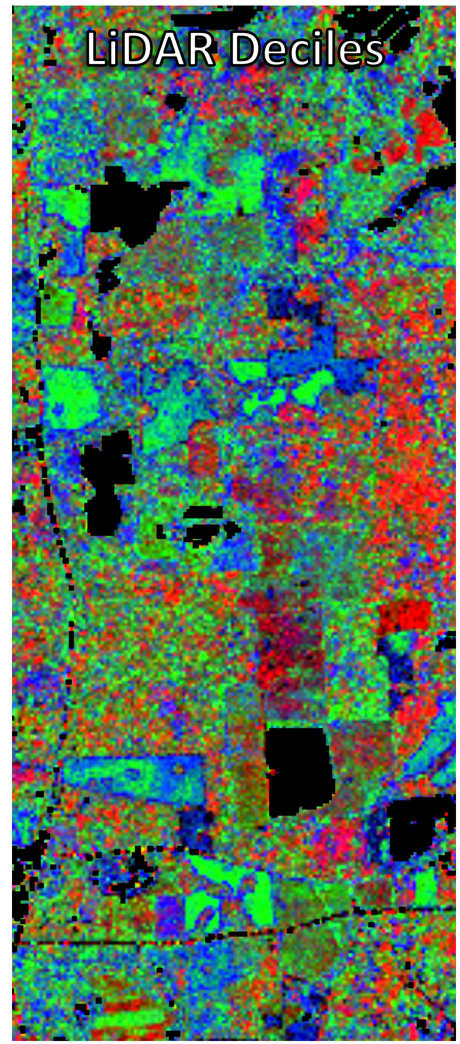
Date	Start acquisition time	End acquisition time	Number of flight lines
Sept 30	14:16	15:38	12
Oct 24	10:09	11:24	13
Oct 25	10:10	11:08	10
Oct 25	12:58	14:11	12
Oct 25	15:34	16:40	11
Oct 27	11:08	12:02	10

Corp, et al.

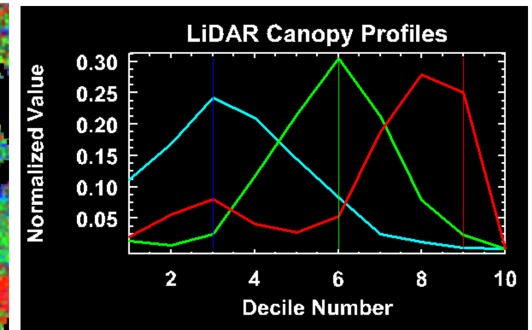
FLEX-US 2013: G-LiHT LiDAR Products

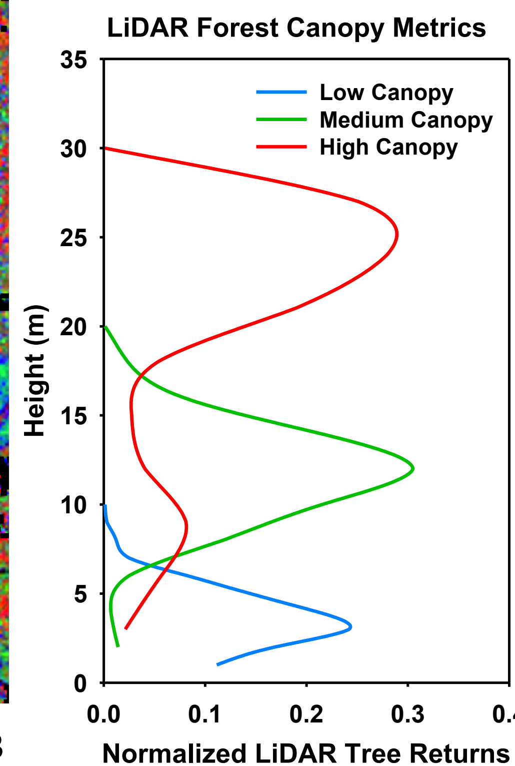
Duke Forest LiDAR Metrics at 14 m Spatial Resolution





Red:D9 Green:D6 Blue:D3

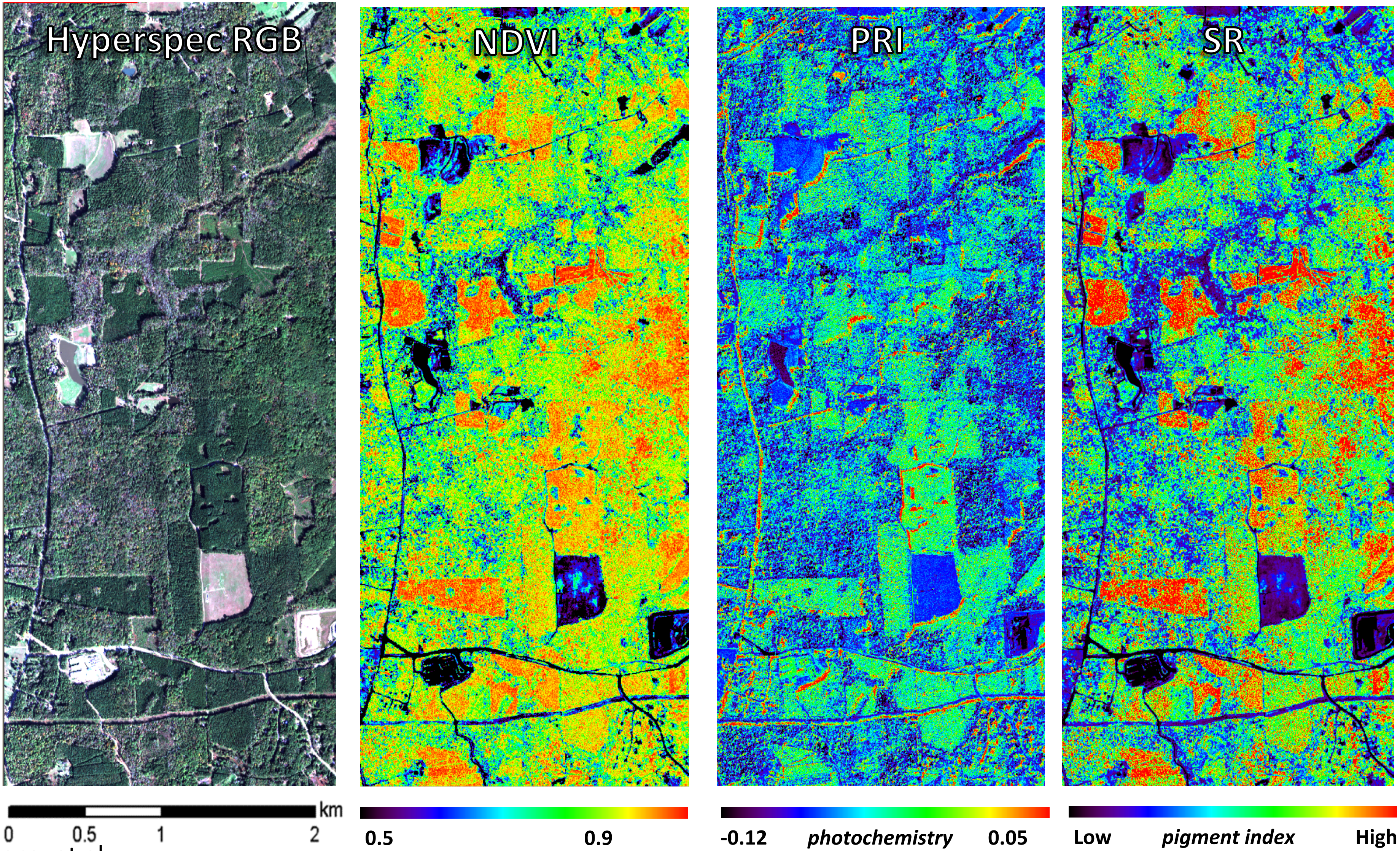




Corp, et al.

FLEX-US 2013: G-LiHT Hyperspectral Products

Duke Forest 10-25 AM Imaging Spectroscopy at 2 m Spatial Resolution

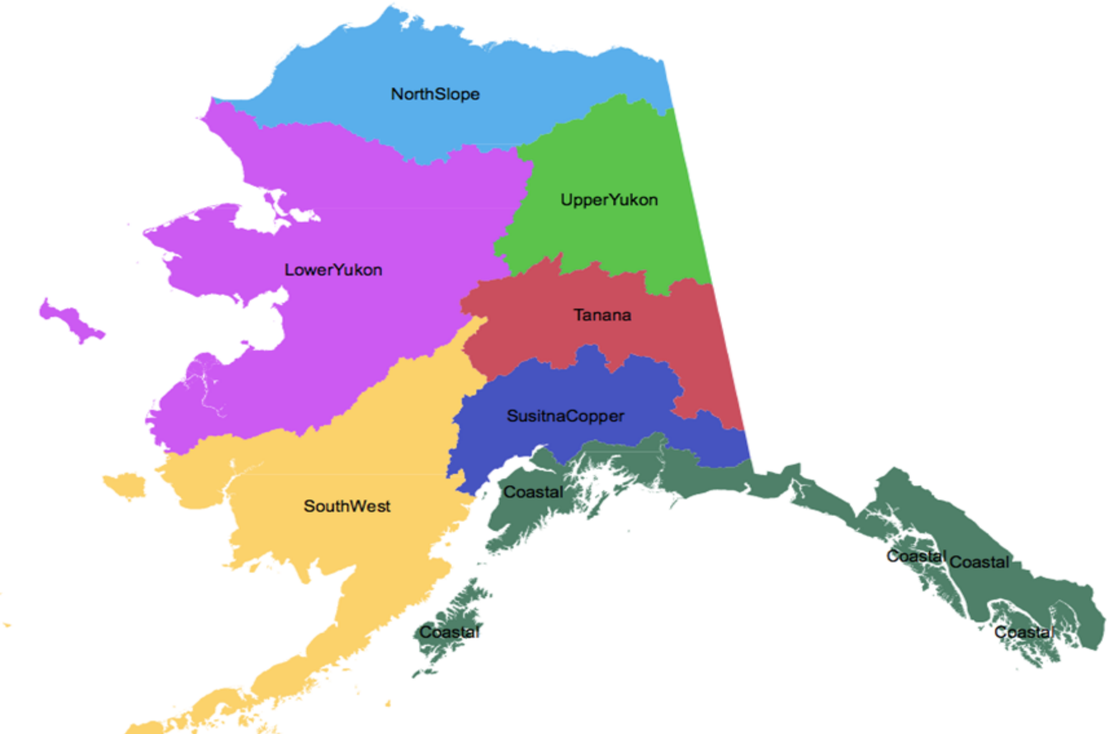


Corp, et al.

G-LiHT: Tanana Alaska Campaign 2014

A USFS-NASA Pilot Project:

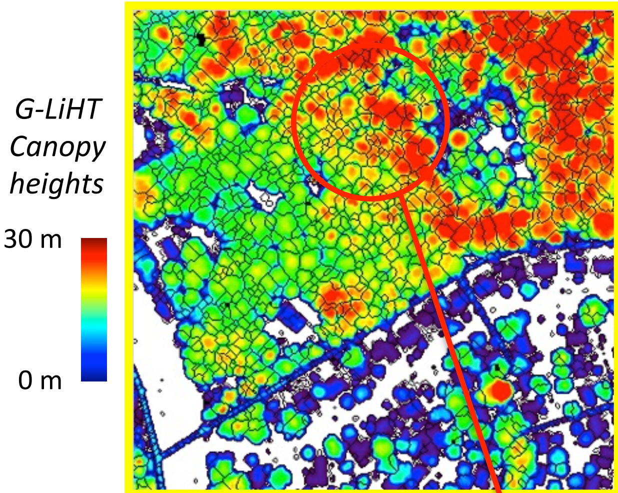
- 44 Days & 230 Flight Hours
- 50,000 km of Flight Lines
- 1,000,000 ha Surveyed
- Mission Cost $100k ($10 per ha)



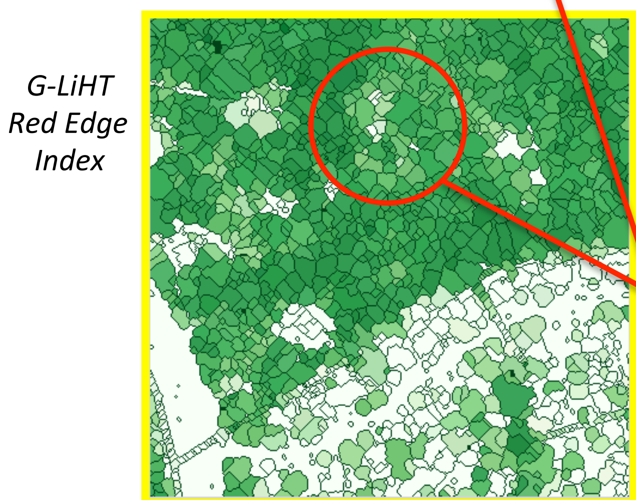
Corp, et al.

G-LiHT: New England Campaign 2014

Step 1: Delineate canopies & structures



Step 2: Extract spectral information



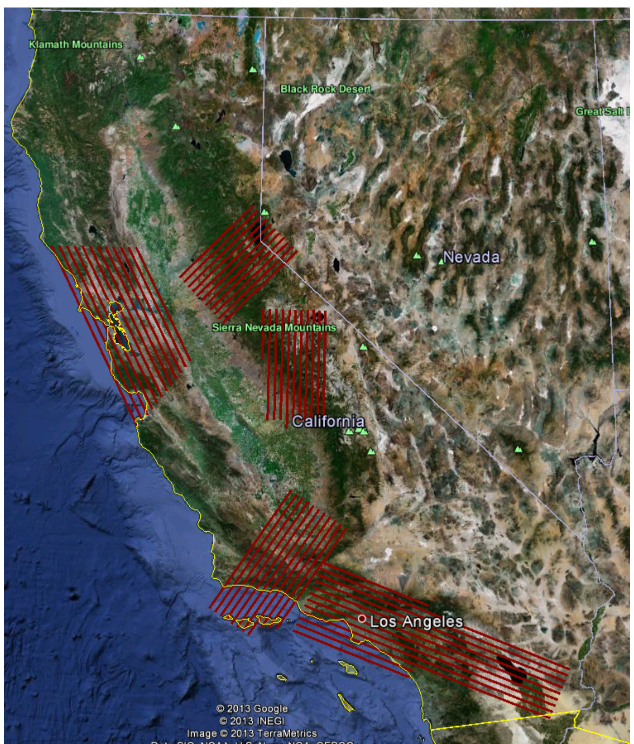
Lidar heights & spectral indices are used to separate trees in decline from openings & structures

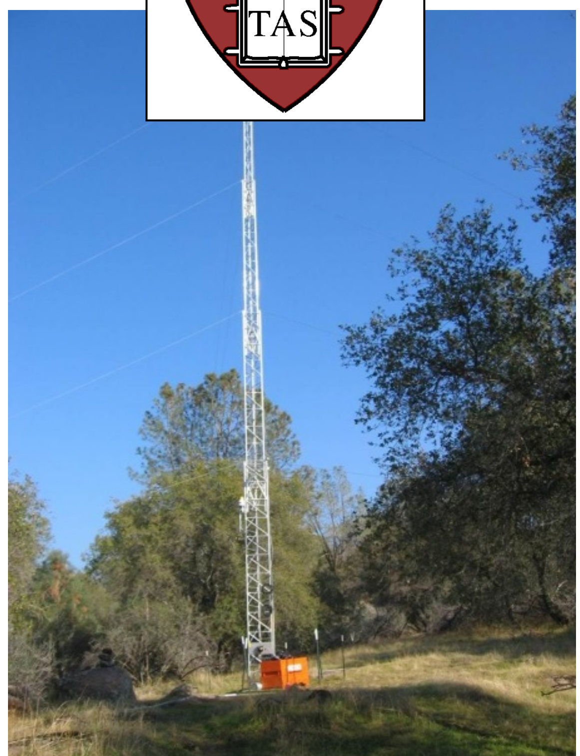
Corp, et al.

Linking Terrestrial Biosphere Models with Remote Sensing Measurements of Ecosystem Composition, Structure, and Function

Paul R. Moorcroft[1], Alexander Antonarakis[1,2], Stacy Bogan[1], Glynn Hulley[3]

1Harvard University
2 University of Sussex
3 Jet Propulsion Lab



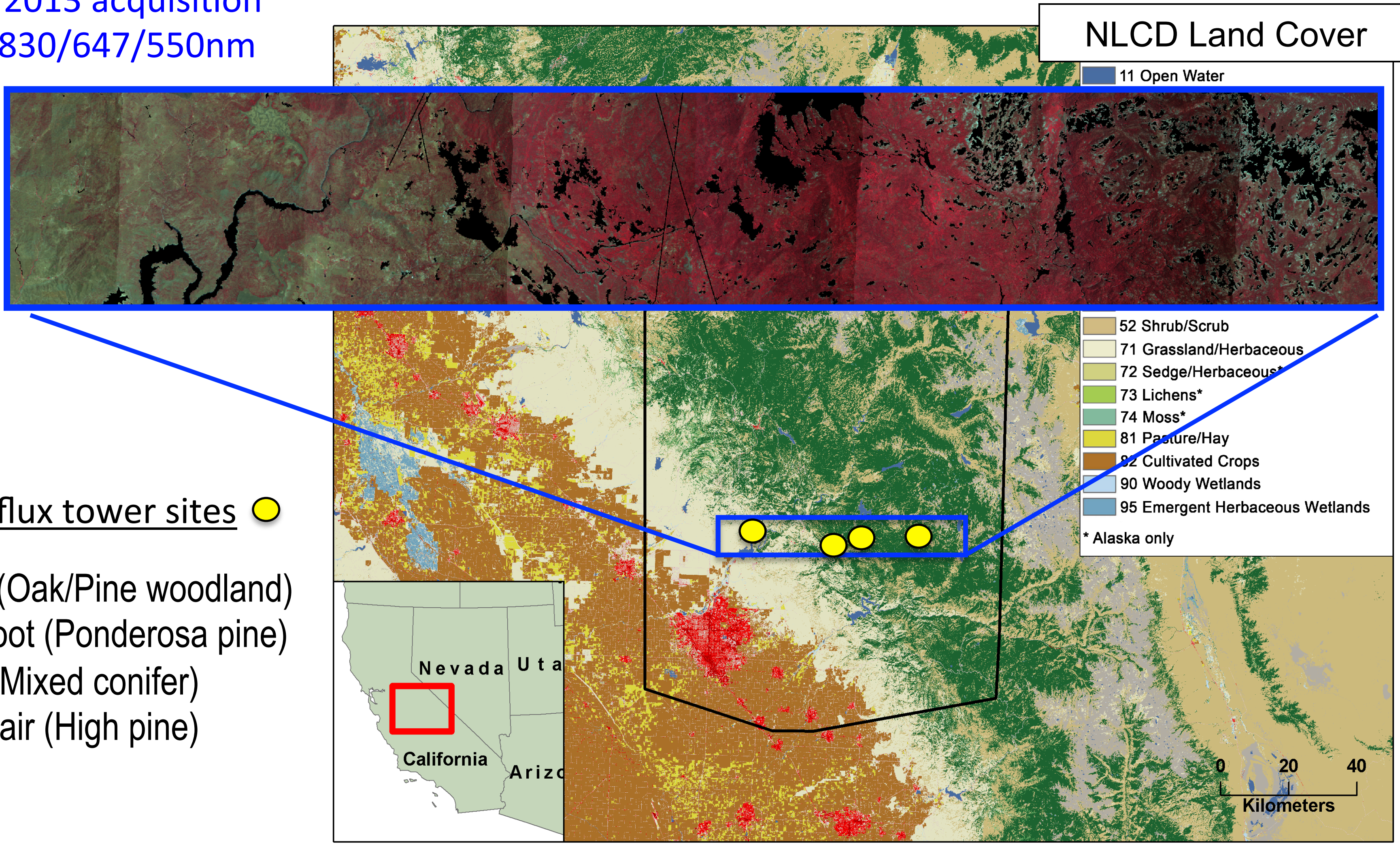


Yosemite/NEON Flight Box

- encompasses the Southern Sierra Critical Zone Observatory (CZO)

~100km east-to-west sample transect of the Yosemite/NEON flight box

June 2013 acquisition
RGB 830/647/550nm



CZO flux tower sites

SJER (Oak/Pine woodland)
Soaproot (Ponderosa pine)
P301 (Mixed conifer)
Shorthair (High pine)

Moorcroft, et al.

Vegetation Spectral Measurements and Field Data Collections, in Support of HyspIRI

John Gamon, U. Alberta, Edmonton
jgamon@gmail.com

Western Peatlands, Alberta, Canada

SpecNet

FIELD SITES | ABOUT SPECNET | SPECNET TOOLKIT | THEMES | CONTACT

SpecNet - Linking optical measurements with flux sampling around the world.

http://specnet.info

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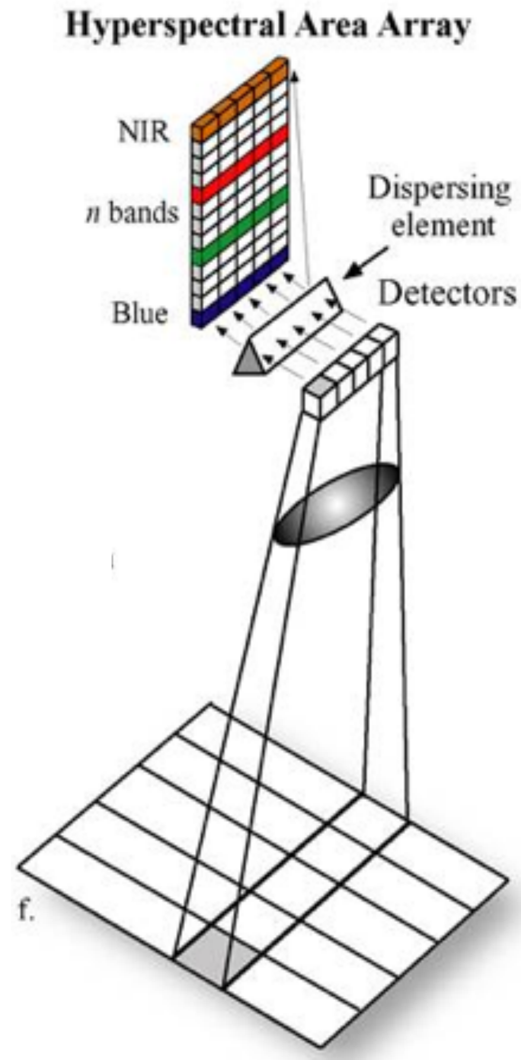
Imaging Spectrometer on Robotic "Tram"

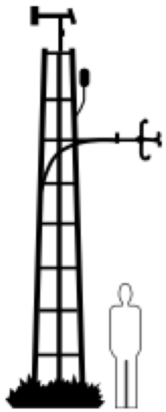
Ran Wang operating the Headwall E-Series

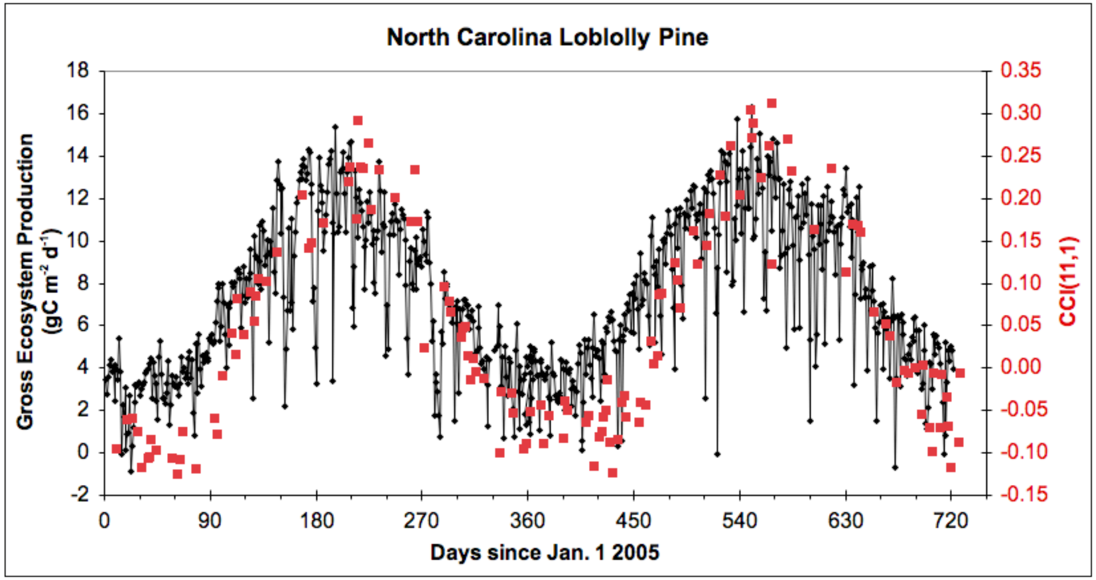


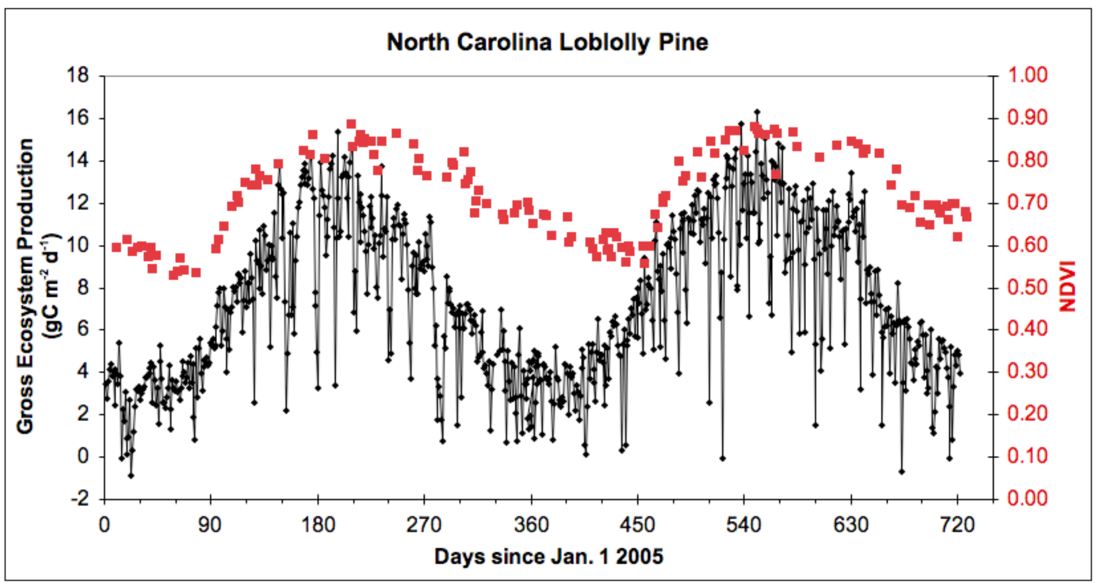
https://www.e-education.psu.edu/geog480/node/494
From Jensen (2007)

Gamon, et al.

CCI does a better job of describing "invisible" evergreen phenology than NDVI







Gamon, et al.

Fig. courtesy Fred Huemmrich

Optical Diversity Studies

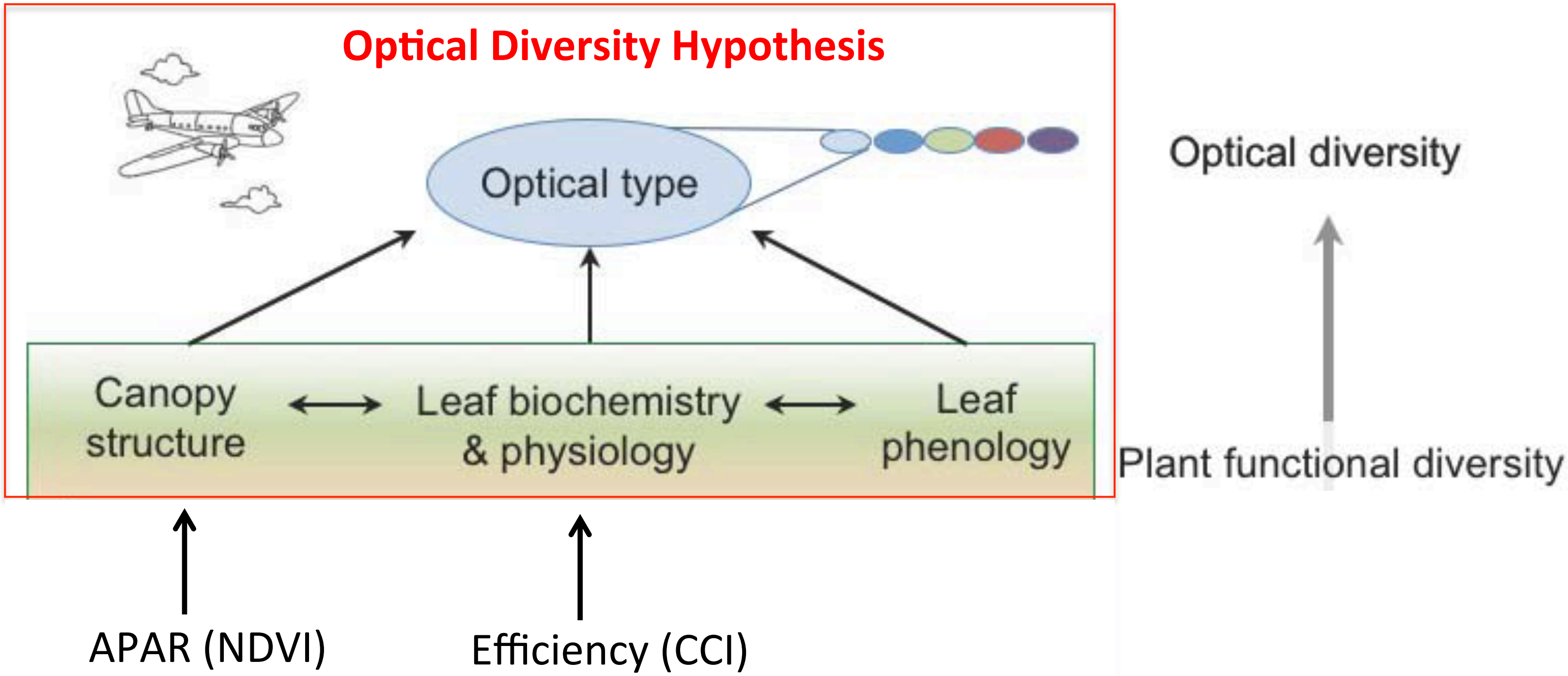


Figure courtesy J. Cavender-Bares (after Ustin & Gamon 2010)

Gamon, et al.

An Overview of Hyperspectral Sensor Calibration/Validation activities at South Dakota State University

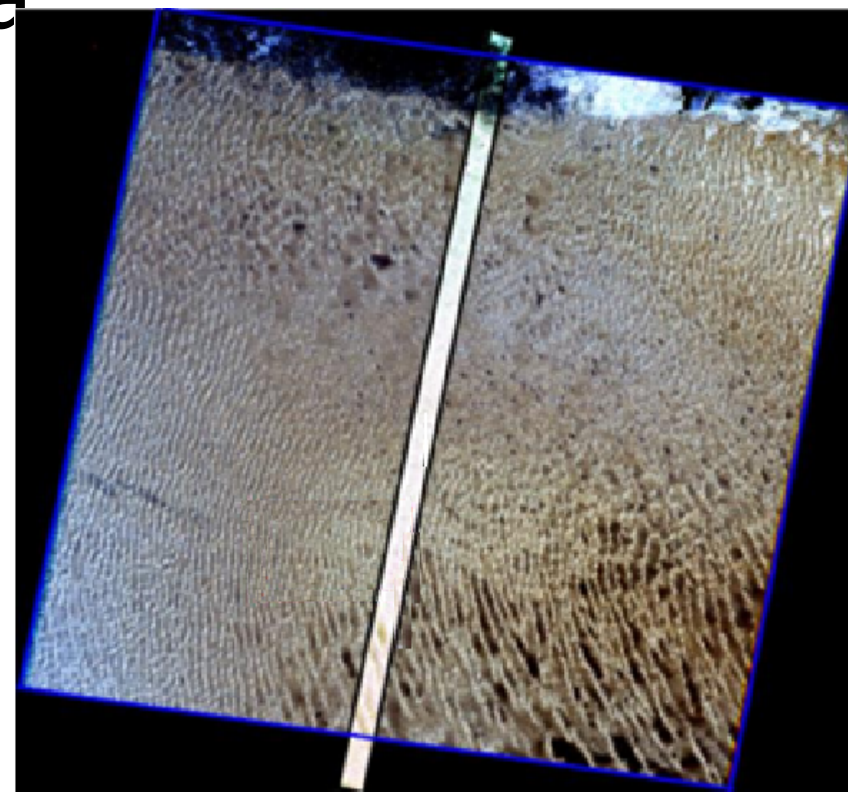
5th Annual HyspIRI Mission & Products Symposium
NASA/GSFC, Greenbelt Maryland
June 3-5, 2015

Dennis Helder
Nischal Mishra
Cibele Teixeira Pinto
Larry Leigh

South Dakota State University
Image Processing Lab

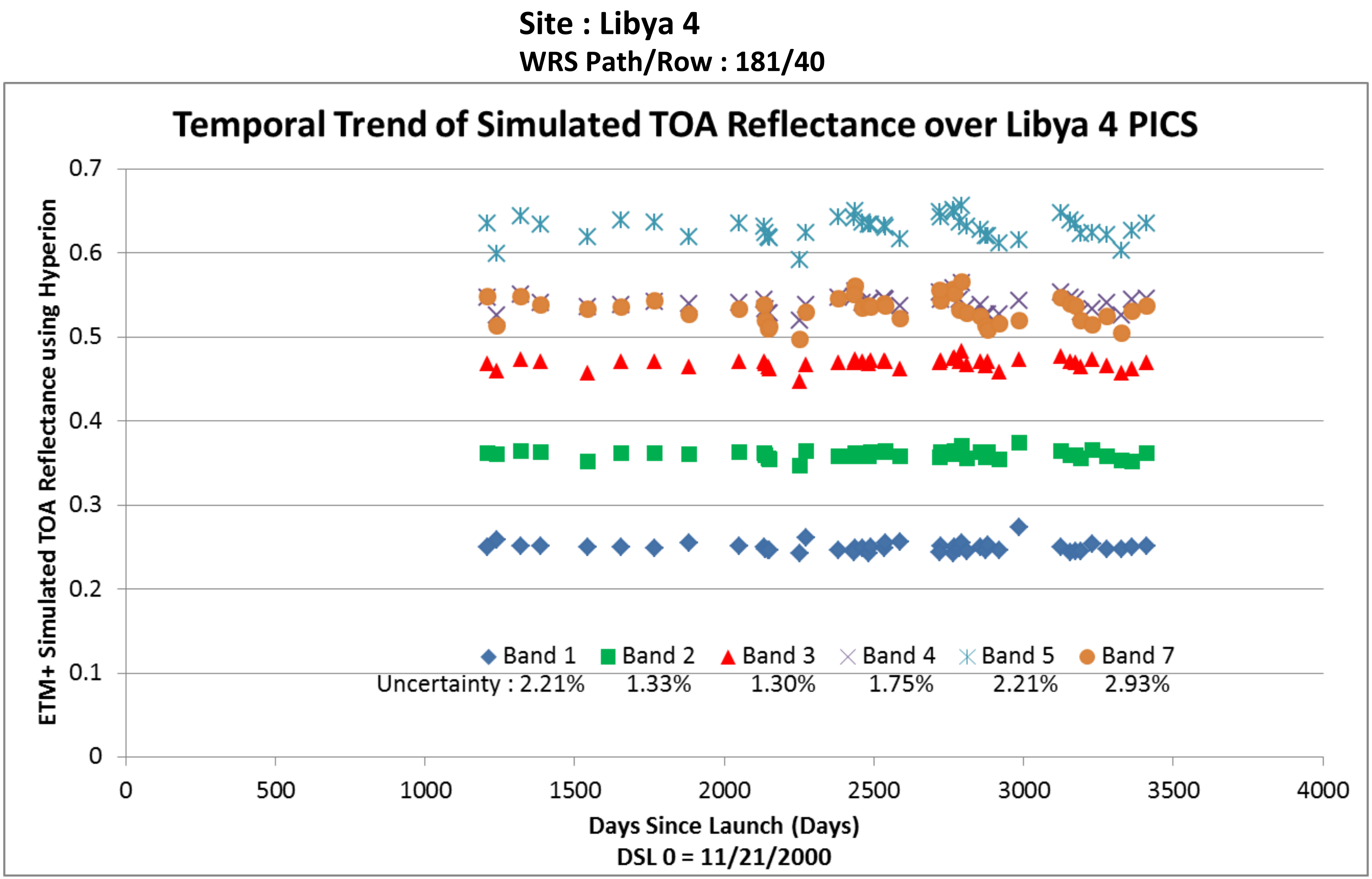
Temporal Analysis of the Hyperion Data

- To evaluate how and when a gain change may have occurred with Hyperion, a temporal stability analysis was performed using 45 cloud-free images from the Libya 4 PICS site
- A 100x100 pixel ROI was chosen and TOA Reflectance was calculated for all six bands of ETM+ which were simulated using the reflectance values from Hyperion and the RSR profile of ETM+
- The simulated reflectance values were plotted against Days Since Launch for all six bands



Helder, et al.

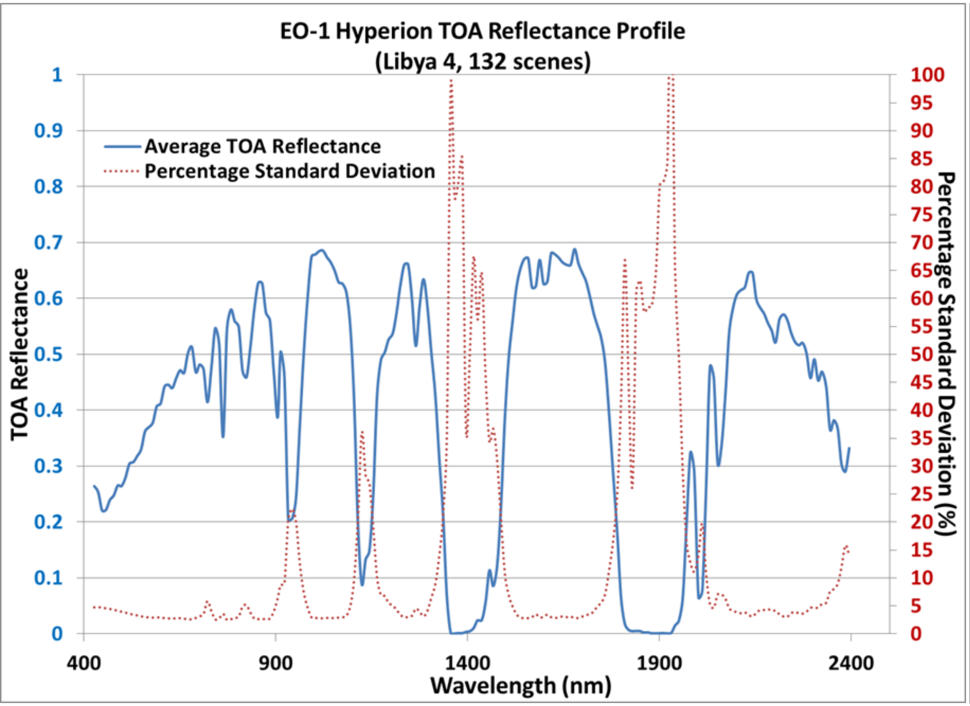
Temporal Trend of Hyperion Simulated TOA Reflectance over Libya 4

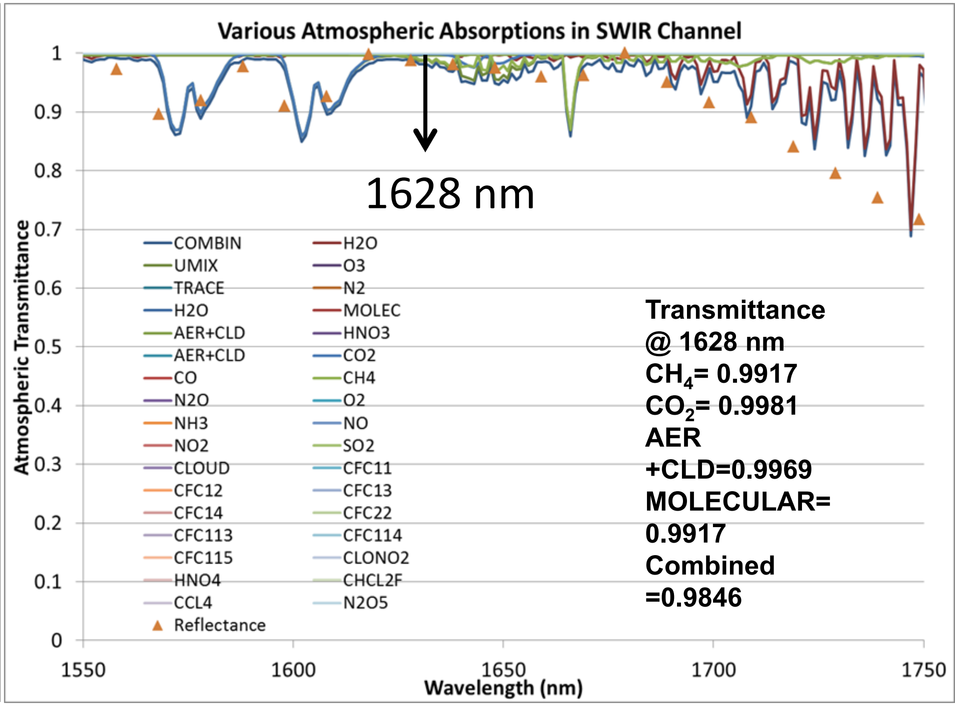


Helder, et al.

LIBYA 4 Stability Based On EO-1 Hyperion

- Temporal stability of the site was studied by selecting spectral channels with very high atmospheric transmittance in the Short Wave Infra-Red region (SWIR).
- The viewing geometry of the sensor was restricted to within +/- 5 degrees to minimize the effects caused by non-nadir viewing.
- Except for the absorption features, the uncertainty is within 4%.





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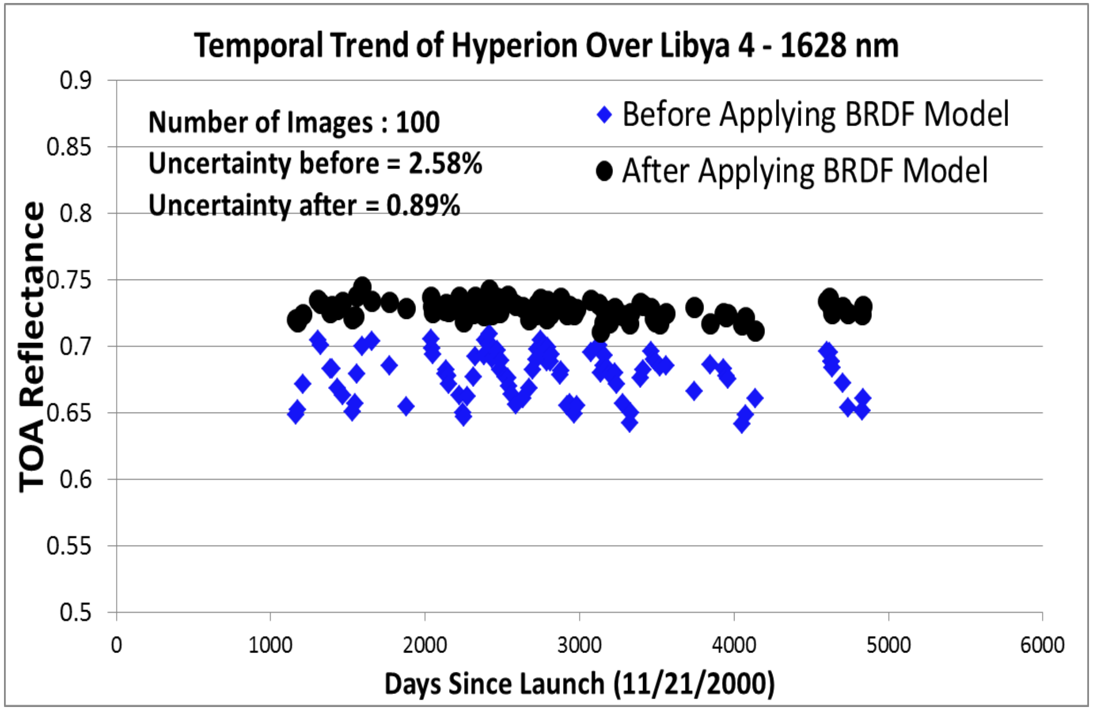
Long term Stability of Hyperion

- EO-1 Hyperion is central for cross-calibration study. Hence the stability of the sensor is crucial.
- Its long term stability is monitored by trending it regularly over PICS.
- Currently tasked to acquire images over Libya 4 PICS and has off-nadir capabilities too.
- Trends over high transmittance regions in the SWIR channel indicate the sensor to be stable to sub 1% when nadir scenes are used.



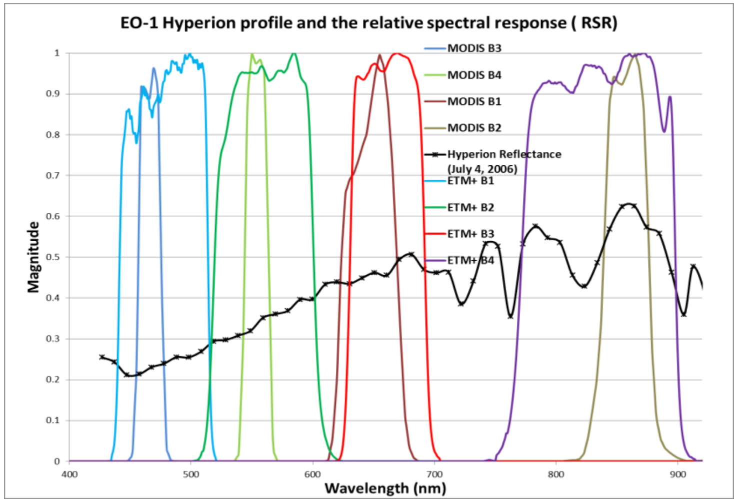
<u>Take home message</u>

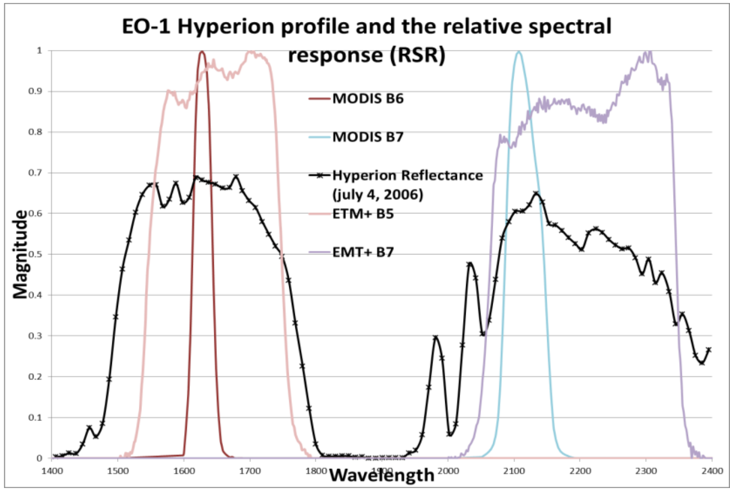
With implementation of a BRDF model in a transparent atmosphere, a sensor can be trended to better than 1% precision.

Helder, et al.

Calculating the scaling factor to anchor Hyperion using Terra MODIS

- Assuming Terra to be the calibration standard, the Hyperion spectrum can be scaled appropriately.
- Scale factor calculated using six available same day pairs (viewing angles < ±5°, solar zenith angle of 30±5°).
- Statistical analysis indicated mean scaling values could be clustered into three groups: band 7, bands 3,2 and 6 and bands 1, 4 (α = 0.05).
- Hyperspectral gain model was then developed using the smooth linear interpolation between these three gain points.





MODIS Bands	7/4/2004	9/6/2004	9/22/2004	9/25/2005	6/24/2006	9/15/2007	Average	STD
3 (459-479 nm)	1.025	0.992	1.001	0.998	0.973	0.979	0.995	1.82%
4(545-565 nm)	1.029	1.006	1.008	1.009	1.000	1.000	1.009	1.05%
1 (620-670 nm)	1.024	1.010	1.007	1.013	1.003	1.001	1.010	0.83%
2 (841-876 nm)	0.993	0.990	0.978	0.988	0.973	0.983	0.984	0.81%
6 (1628-1652 nm)	0.996	1.001	0.991	0.999	0.977	0.984	0.992	0.95%
7 (2105-2155 nm)	0.986	0.974	0.960	0.966	0.952	0.954	0.965	1.32%

Helder, et al.

VIIRS Bias Analysis using Hyperion

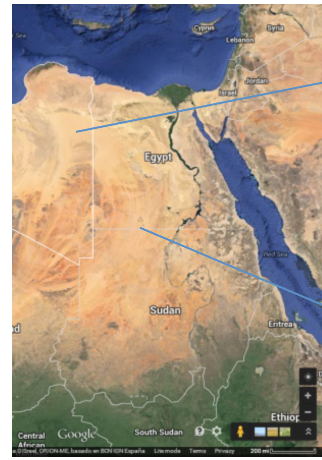
Sirish Uprety and Changyong Cao

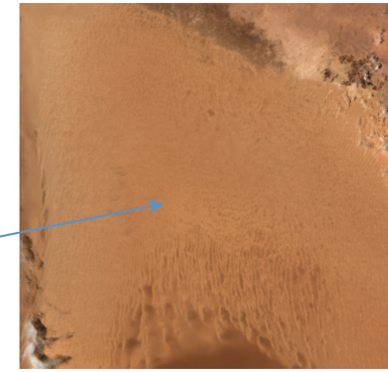
CIRA, Colorado State University and NOAA/NESDIS/STAR

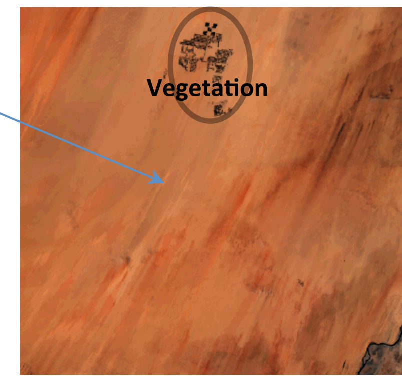
Calibration Sites Used

Libya-4 and Sudan-1

- Libya-4 (28.55, 23.39) is a CEOS endorsed cal/val site.
- Both Libya-4 and Sudan-1 are Saharan desert sites used mostly for on-orbit cal/val of VNIR radiometers.
- Sudan-1 (21.74, 28.22) is used by NOAA series AVHRR for post-launch relative calibration.
- VIIRS nadir observations are collected to study the radiometric performance.





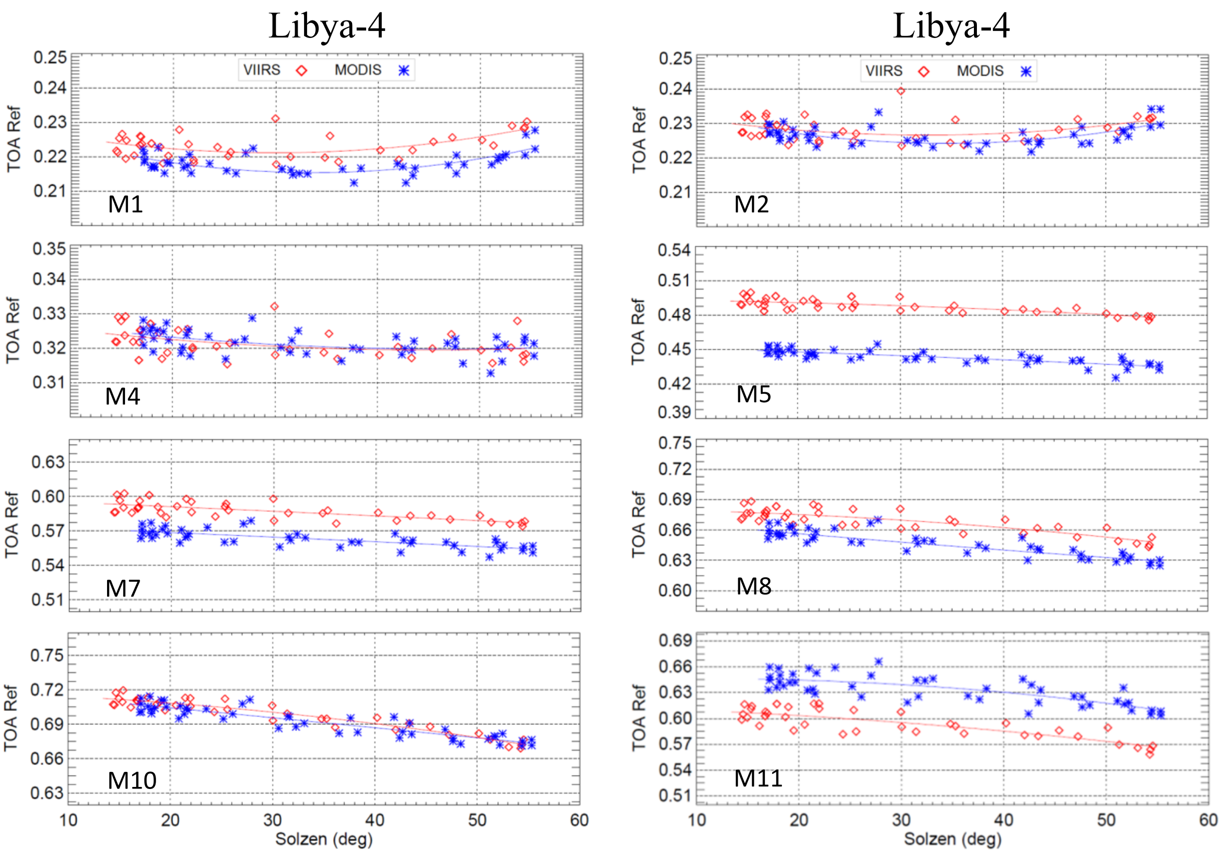


Antarctica Dome C

- Dome C (-75.102°, 123.395°) is also a CEOS cal/val site.
- Large homogenous snow field in Antarctica at an altitude of 3.2 km
- high altitude; high reflectance; > 75% of cloud-free time; low water vapor content; very cold and dry climate; low aerosol and dust etc.
- Limitations: accessibility, availability of data only during austral summer, high BRDF, not visible by GOES/GOES-R instruments etc.

Uprety, et al.

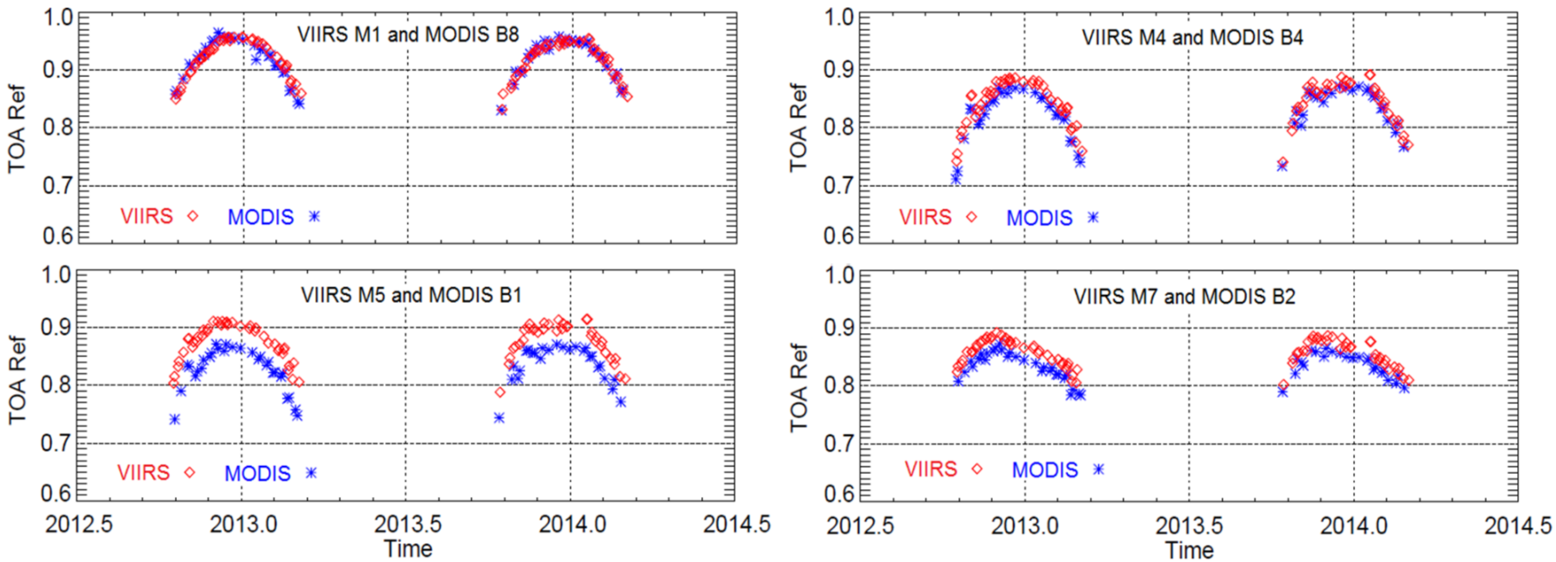
VIIRS Bias Relative to MODIS



VIIRS		MODIS		Libya-4	Sudan-1
Band	Wavelength (µm)	Band	Wavelength (µm)	Bias @ solzen=18°	
M1	0.402 - 0.422	8	0.405 - 0.420	1.65% ± 0.31%	1.54% ± 0.24%
M2	0.436 - 0.454	9	0.438 - 0.448	0.31% ± 0.42%	0.15% ± 0.27%
M3	0.478 - 0.498	10	0.483 - 0.493	1.32% ± 0.42%	1.36% ± 0.28%
M4	0.545 - 0.565	4	0.545 - 0.565	-0.23% ± 0.39%	-0.04% ± 0.35%
M5	0.662 - 0.682	1	0.620 - 0.670	9.5% ± 0.40%	10.05% ± 0.54%
M7	0.846 - 0.885	2	0.841 - 0.876	3.95% ± 0.53%	3.99% ± 0.64%
M8	1.230 - 1.250	5	1.230 - 1.250	2.74% ± 0.64%	2.96% ± 0.84%
M10	1.580 - 1.640	7	1.628 - 1.652	0.54% ± 0.41%	0.85% ± 0.39%
M11	2.225 - 2.275	6	2.105 - 2.155	-6.3% ± 0.96%	-5.61% ± 0.98%

Uprety, et al.

Dome C TOA Reflectance

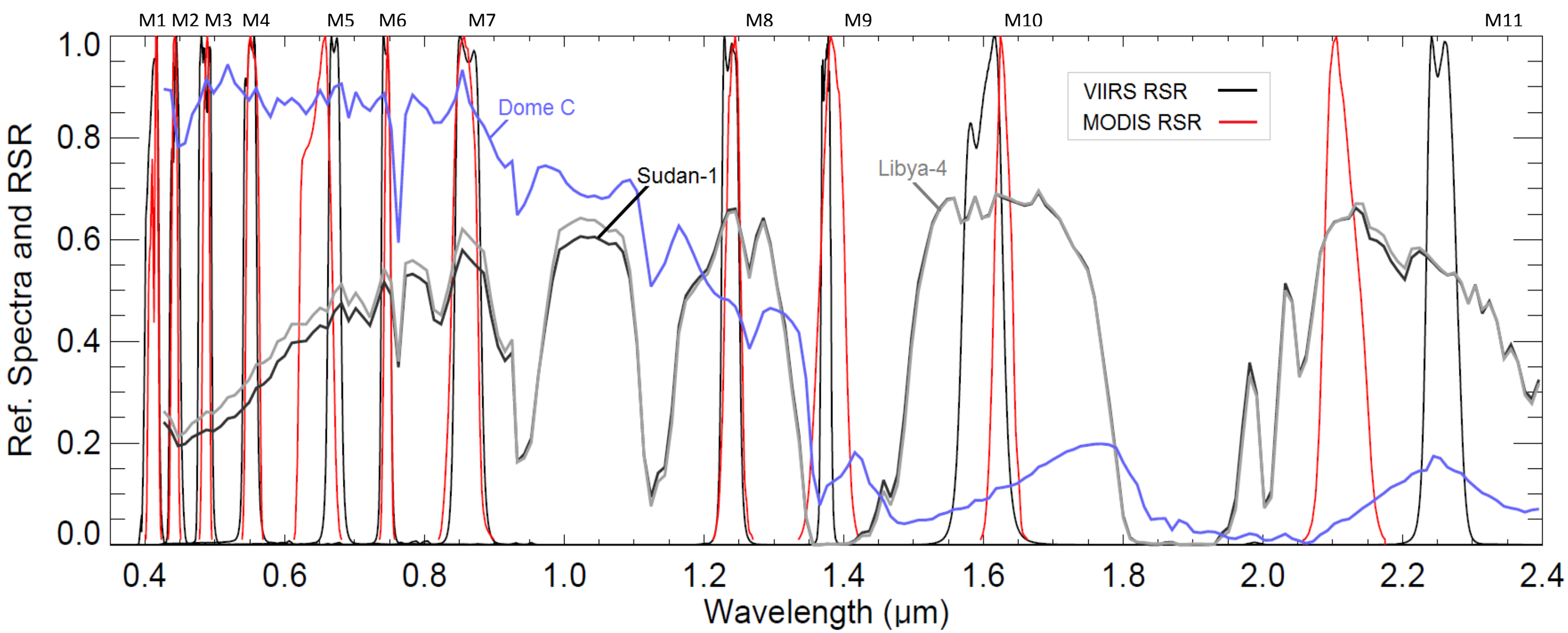


- Large BRDF
- Some VIIRS bands agree well with MODIS and some suggest large bias.
- MODIS matching bands for M2 and M3 are saturated at larger solar elevation.

VIIRS		MODIS		Dome C
Band	Wavelength (μm)	Band	Wavelength (μm)	Bias @ solzen=18°
M1	0.402 - 0.422	8	0.405 - 0.420	-0.14% ± 0.65%
M2	0.436 - 0.454	9	0.438 - 0.448	-0.50% ± 0.67%
M3	0.478 - 0.498	10	0.483 - 0.493	-0.20% ± 0.79%
M4	0.545 - 0.565	4	0.545 - 0.565	1.62% ± 1.64%
M5	0.662 - 0.682	1	0.620 - 0.670	5.00% ± 1.28%
M7	0.846 - 0.885	2	0.841 - 0.876	2.93% ± 1.44%

Uprety, et al.

Spectral Characteristics Using Hyperion



- Dome C is more flat in VNIR region whereas desert sites are better for longer wavelengths.
- Observed bias depends on target spectral characteristics and RSR differences.
- Large bias for some VIIRS bands exists mainly due to the differences in spectral response functions of instruments.
- If the spectral characteristics of the sites are well characterized, the impact of spectral differences in inter-comparison can be accounted.

Uprety, et al.

Hyperion and GOSAT FTS over Libya-4

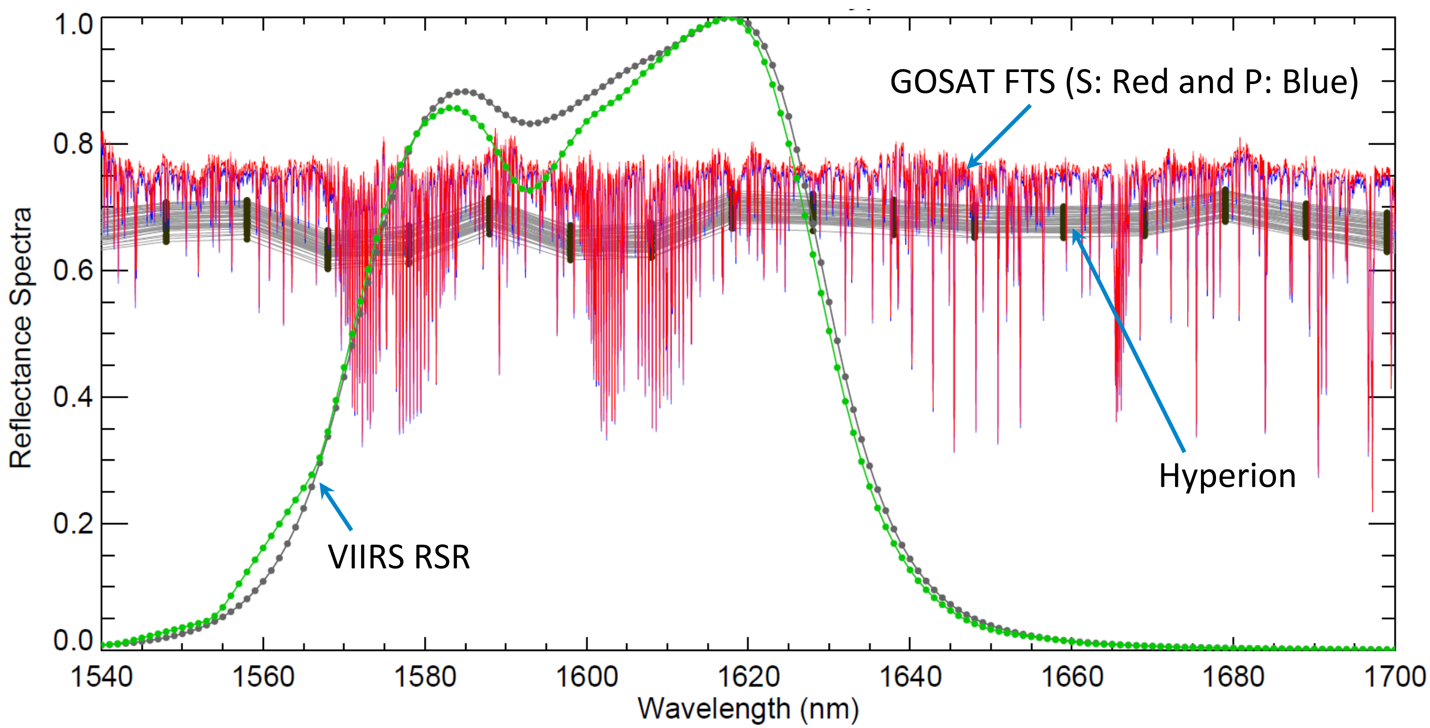
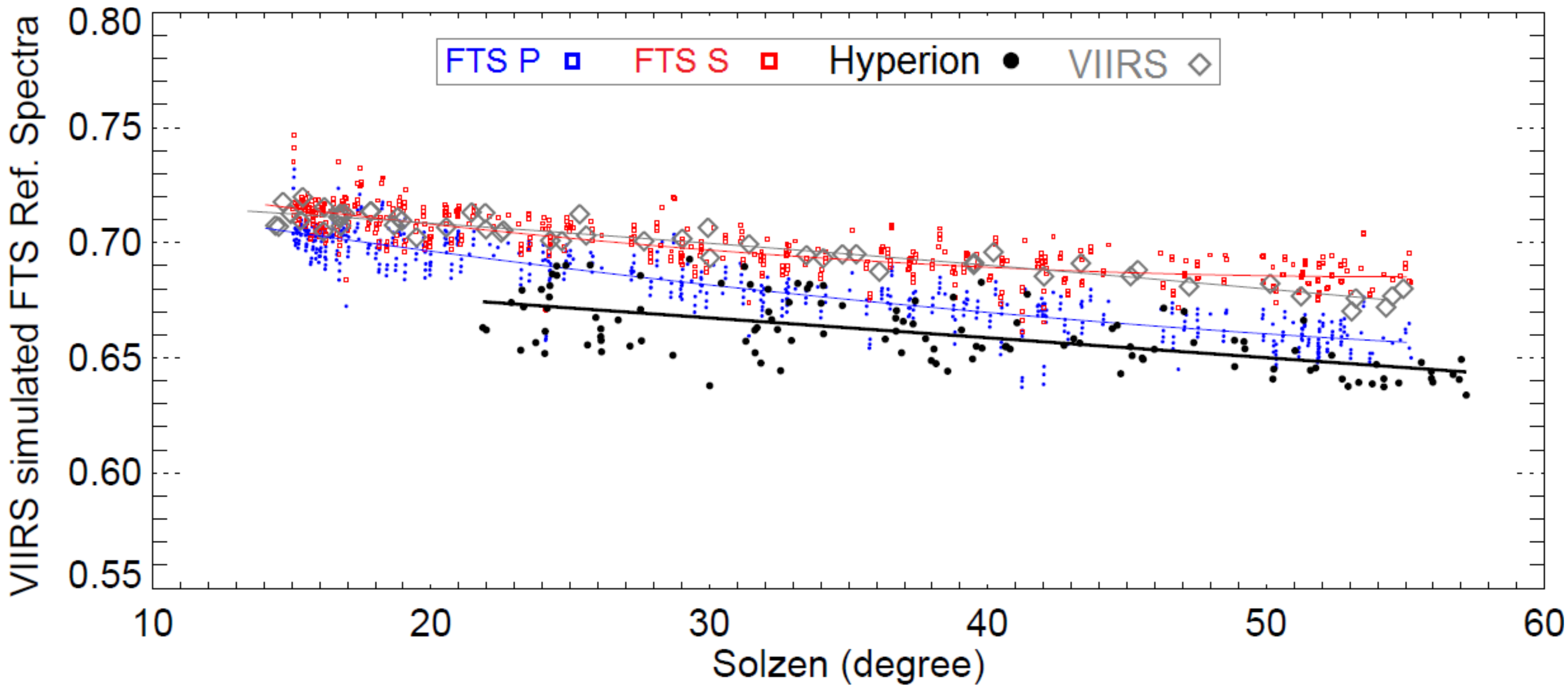


Figure. GOSAT FTS Band 2 (1.6 µm) along with Hyperion reflectance (57 observations) over Libya-4. VIIRS M and I bands are completely covered by FTS L1b spectra.

- *GOSAT FTS measurements near Libya-4 are higher than Hyperion*

Uprety, et al.

Hyperion and GOSAT FTS Comparison



- Hyperion and FTS measurements are convolved with VIIRS and plotted.
- Larger bias with S polarized light compared to P polarization.
- Inconsistency between S and P polarized measurements ranges from about 1.2% to nearly 3%.
- Larger discrepancy between Hyperion and FTS could be due to a number of reasons such as use of different solar models (Hyperion: CHKUR and FTS: Kurucz), collocation error, BRDF, low spectral resolution of Hyperion and calibration uncertainties.

Uprety, et al.

Libya-4 PICS Surface Reflectance Time-Series and Hyperion Radiometric Stability

Christopher Neigh[1], Joel McCorkel[1], Petya Campbell[2], Laurence Ong[3], Vuong Ly[1], David Landis[4], Stuart Fry[5], and Elizabeth Middleton[1]

EO-1 Science Team

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2 University of Maryland, Baltimore County, NASA/GSFC, Greenbelt, MD 20771

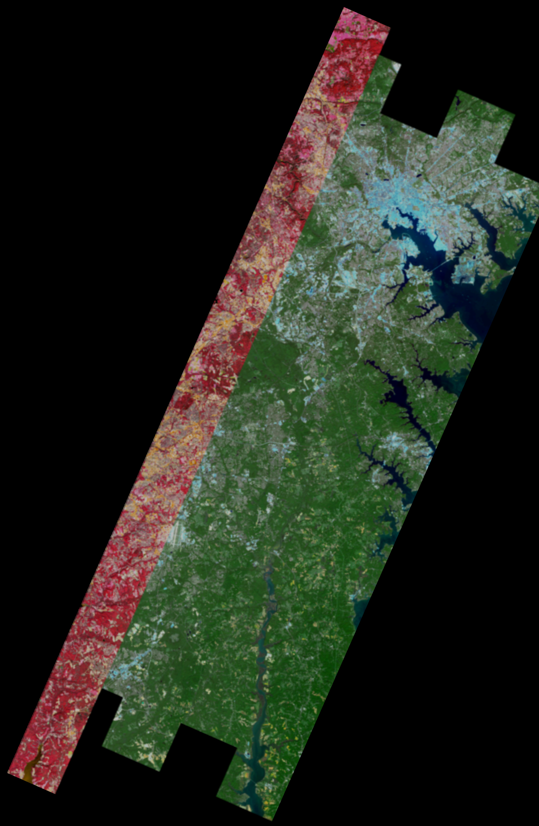
3 Science Systems Applications Inc., Lanham, MD 20706

4 Sigma Space Corp., Lanham, MD 20706

5 Stinger Ghaffarian Tech., Greenbelt, MD 20770

HyspIRI Symposium

6/4/2015



Hyperion (red) overlay on ALI Image (green), Oct 2012 Baltimore, MD

Introduction

<u>Objectives/Questions</u>

1. Can high-resolution commercial data be used to understand sub 30m pixel variability in Hyperion data?

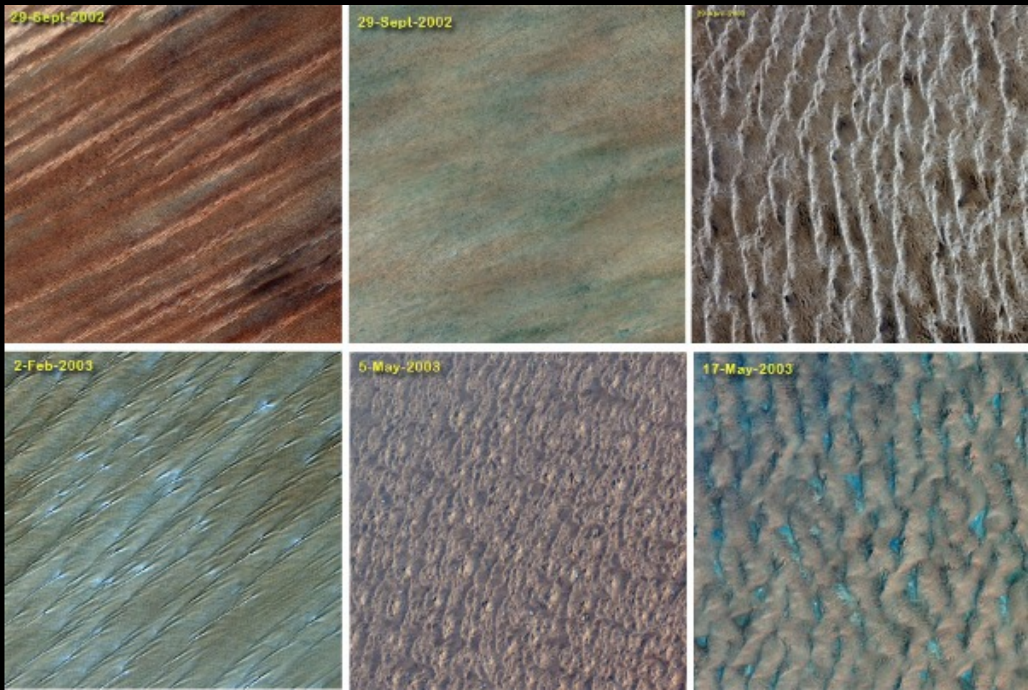
2. How stable is Hyperion through time with atmospherically corrected land surface reflectance from 3 correction approaches?

3. Can Hyperion be used to cross calibrate a virtual constellation for land surface imaging?

<u>Study Area</u>

- CEOS – core validation sites
  - Hyperion data has been routinely collected in the Libyan desert (Libya-4)
  - Other studies have used this site to monitor sensor degradation and cross-calibrate measurements
  - Landsat ETM+, MSS, SRTM, MODIS, EO-1

Chander et al. 2010 RSE

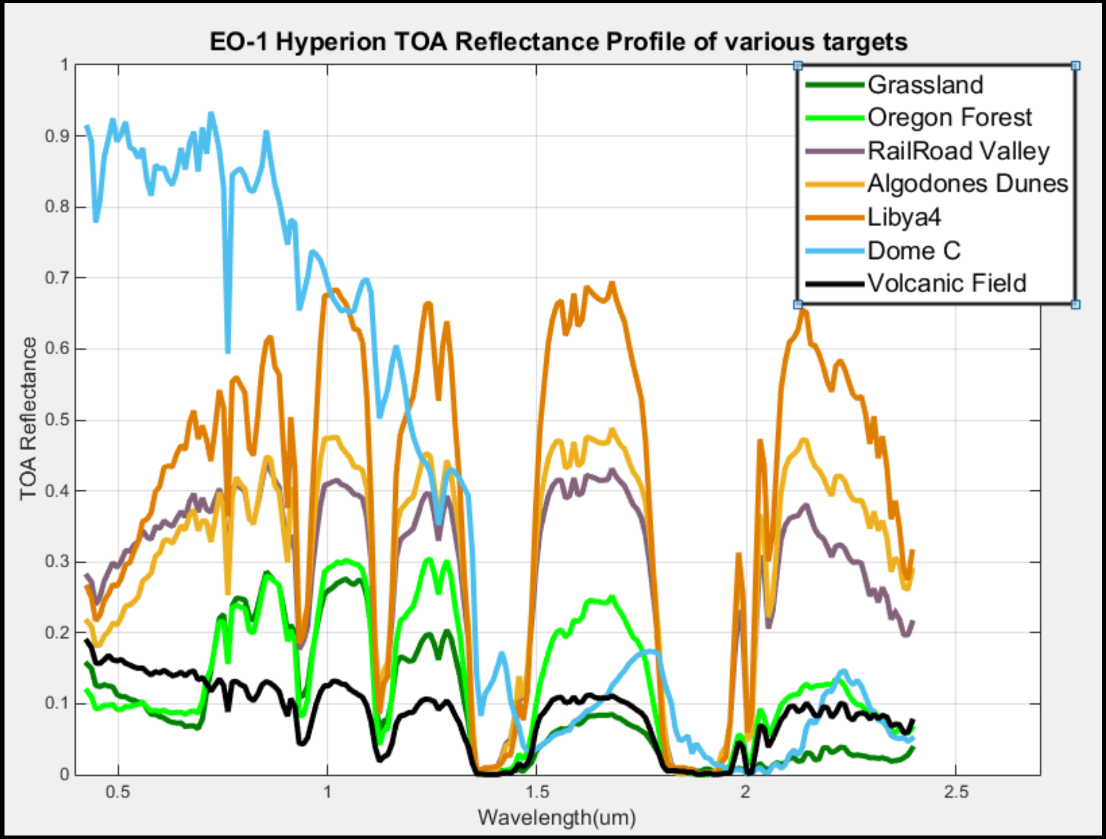


Neigh, et al.

Why Libya-4 PICS?

From:
On-orbit calibration: Use of psuedo invariant calibraiton sites (PICS), vicarious campaigns, and global averaging

- Hyperion acquisitions over different land cover types have been collected and evaluated.
  - Bright Deserts PICS (Libya 4, Algodones Dunes)
  - Medium Bright Playa PICS (RVPN)
  - Vegetation (Oregon Forest, SDSU test vegetation site)
  - Snow (Dome C)
  - Dark PICS (Volcanic field in Libya)



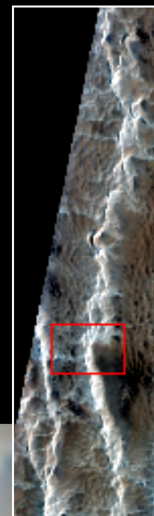
Neigh, et al.

D. Helder, N. Mishra, ***L. Leigh and*** *D. Aaron. Update on Pre-Cursor Calibration Analysis of Sentinel 2. April 23, 2015 - LCLUC*

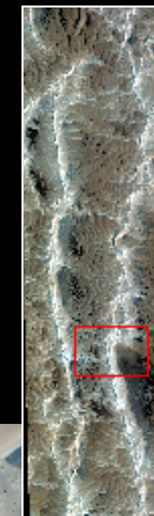
Subset example of Hyperion vs. WorldView-2

Linear stretch applied to enhance image visualization , Hyperion co-registered to WV-2

Hyperion True Color Convolved
FLAASH
8/9/2012
Red 630-690 nm
Green 510-580 nm
Blue 450-510 nm
Cubic Convolution 2m



WorldView-2 True Color
FLAASH
8/12/2012
Red Band 5 630-690 nm
Green Band 3 510-580 nm
Blue Band 2 450-510 nm
2m



Summary

- Hyperion is very stable through time.
  - In most Vis bands < 0.24% yr^{-1}, most other bands <0.4% yr^{-1} compared to other TOA reflectance studies >0.675% yr^{-1}
- FLAASH vs. ATREM vs. ACORN
  - Consistent in Vis and variable in NIR and SWIR
  - Bands impacted more by atmospheric absorption have more variance between approaches
- Libya-4 CEOS site exhibits variability from 30m to 2m that can be quantified with a high resolution digital terrain model
  - Variation in dune topography impacts BRDF and observed reflectance
  - Difficult to distinguish between sensor/product differences and actual resolution differences
- Is a virtual constellation possible with spaceborne spectrometer measurements?
  - We provide enhanced estimates of instrument stability useful for cross calibration studies from 30-m to 2-m resolution. FLAASH reflectance between convolved Hyperion and WorldView-2 are reasonably good in homogenous areas (CV <2%).

    ($R2 > 0.64$-0.77, p-val < 0.001)

    Low correlation heterogeneous areas (CV 5-7%).

    ($R2 <0.19$-0.24, p-val < 0.001)
  - Libya-4 heterogeneity should be considered when convolving and or cross-calibrating data at high resolution or efforts should be made to minimize site conditions that introduce errors.

Neigh, et al.

Advances in Wildfire Remote Sensing: report back from Twenty-Third Tactical Fire Remote Sensing Advisory Committee (TFRSAC) Meeting

Hosted By:

USDA-Forest Service: Everett Hinkley and Brad Quayle

NASA Applied Science Program: Vince Ambrosia

27-28 May 2015

NASA- Ames Research Center

Moffett Field, CA

Earth Science Decadal Survey

Research and Management

What key questions and advancements does the **Wildfires** science and applications community need to address in the next 10-15 years?

What key questions – if addressed well or answered – would make major advances in our knowledge *and* its use in decisions and actions?

What are key questions and challenges that address both scientific needs and societal decisions?

*In addition to research questions and reasons for measurements, input from **Wildfires** users/managers on needs for advancement and what that impact can mean on the ground can provide language to the Decadal Survey panels to*
a) help with influence within panel discussions and
b) write more cogent, compelling rationales.

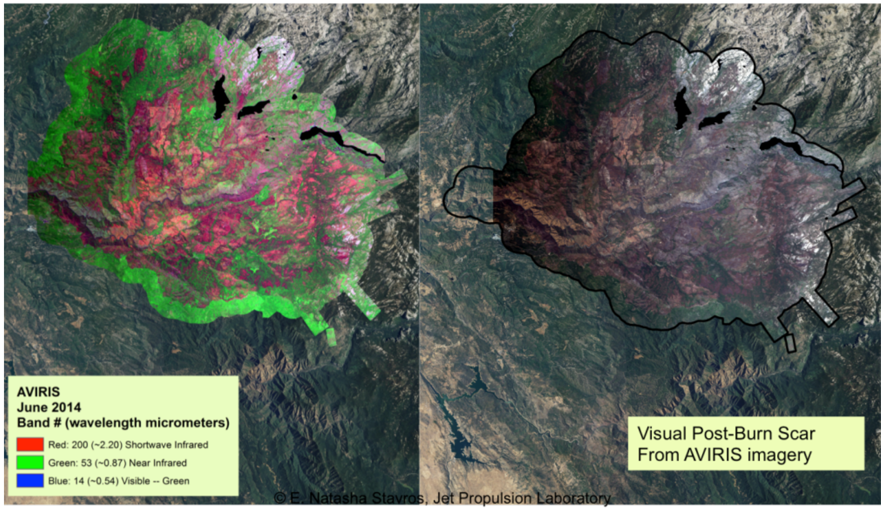
Megafire Disaster Response: NASA / USFS Aid Fire Recovery

- **Objective:** characterize pre, active and post-burn conditions of megafires, to observe ecosystem properties influencing fire probability, behavior and recovery as a basis for aiding management

- **Coverage:** California King (2014) and Rim (2013) megafires

- **Data collection, processing and dissemination** (wildfire.jpl.nasa.gov) is a collaborative effort that aids disaster response and post-fire recovery planning such as:
  - Identify endangered species habitat
  - Water quality assessment
  - Erosion assessment
  - Removal of hazardous logs
  - Timber harvesting

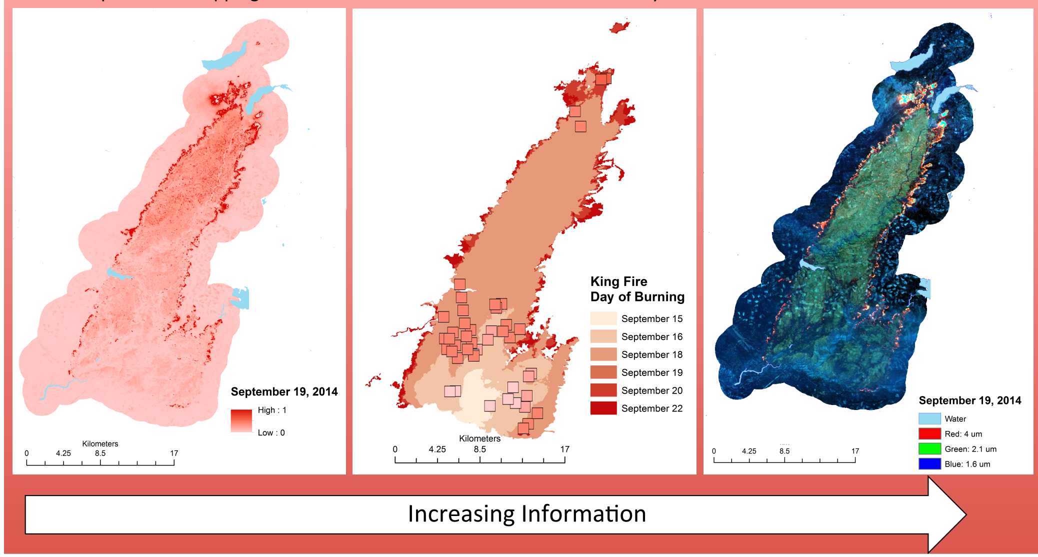
AVIRIS hyperspectral improves burn area imaging over Rim Fire

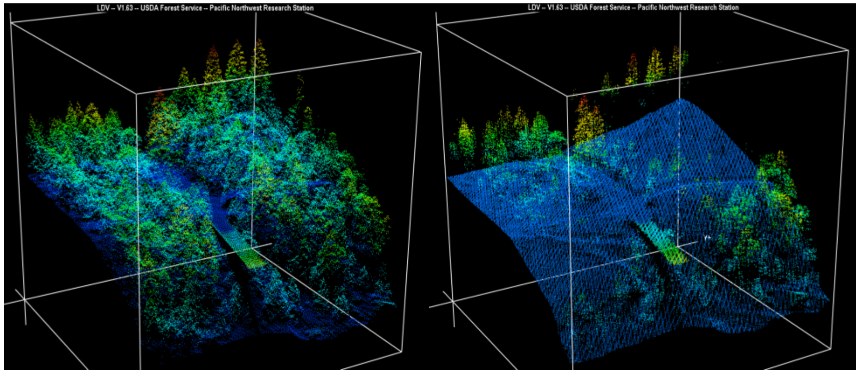


A) MASTER – 1 thermal infrared band, a proxy for NIROPS (~ 1 m resolution) used in active fire management perimeter mapping

B) NIROPS progression with MODIS multi-band thermal infrared active fire pixels (~ 1000 m resolution) can be used to calculate Fire Intensity

C) MASTER multiband thermal infrared (35 m resolution)





LiDAR before (left) and after (right) King Fire

Sohlberg, et al.

Observing Volcanic Eruptions with *Earth-Observing 1*: Smart Software, and the Volcano Sensor Web

Ashley Davies

Jet Propulsion Laboratory-California Institute of Technology, Pasadena, CA, USA

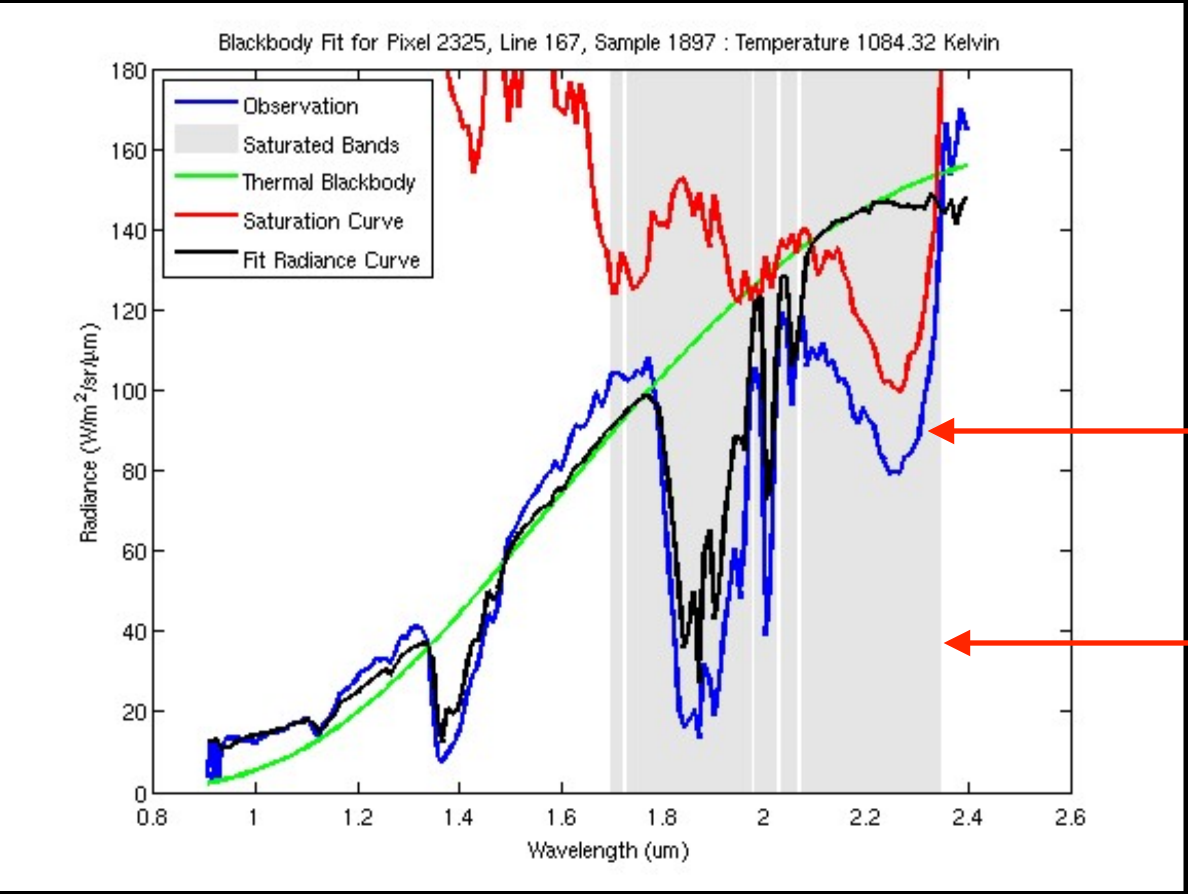
HyspIRI Symposium, Washington, DC, 4 June 2015

Volcano Monitoring and ***EO-1***

- *EO-1* has been a superb platform for detecting and monitoring volcanic activity (inc. making exceptional use of nighttime data)
- Also for technology demonstrations:
- Autonomous Sciencecraft Experiment – ASE
  - New Millennium Program – Space Technology-6
- Orbital asset incorporated into Sensor webs – flood, fire, volcanoes
  - Volcano Sensor Web (VSW)
  - Template for HyspIRI

EO-1 and volcanic activity

- Hyperion is *great for* imaging erupting volcanoes
- Wavelength range is sensitive to pixel brightness temps >450 K



"dip" = saturation feature

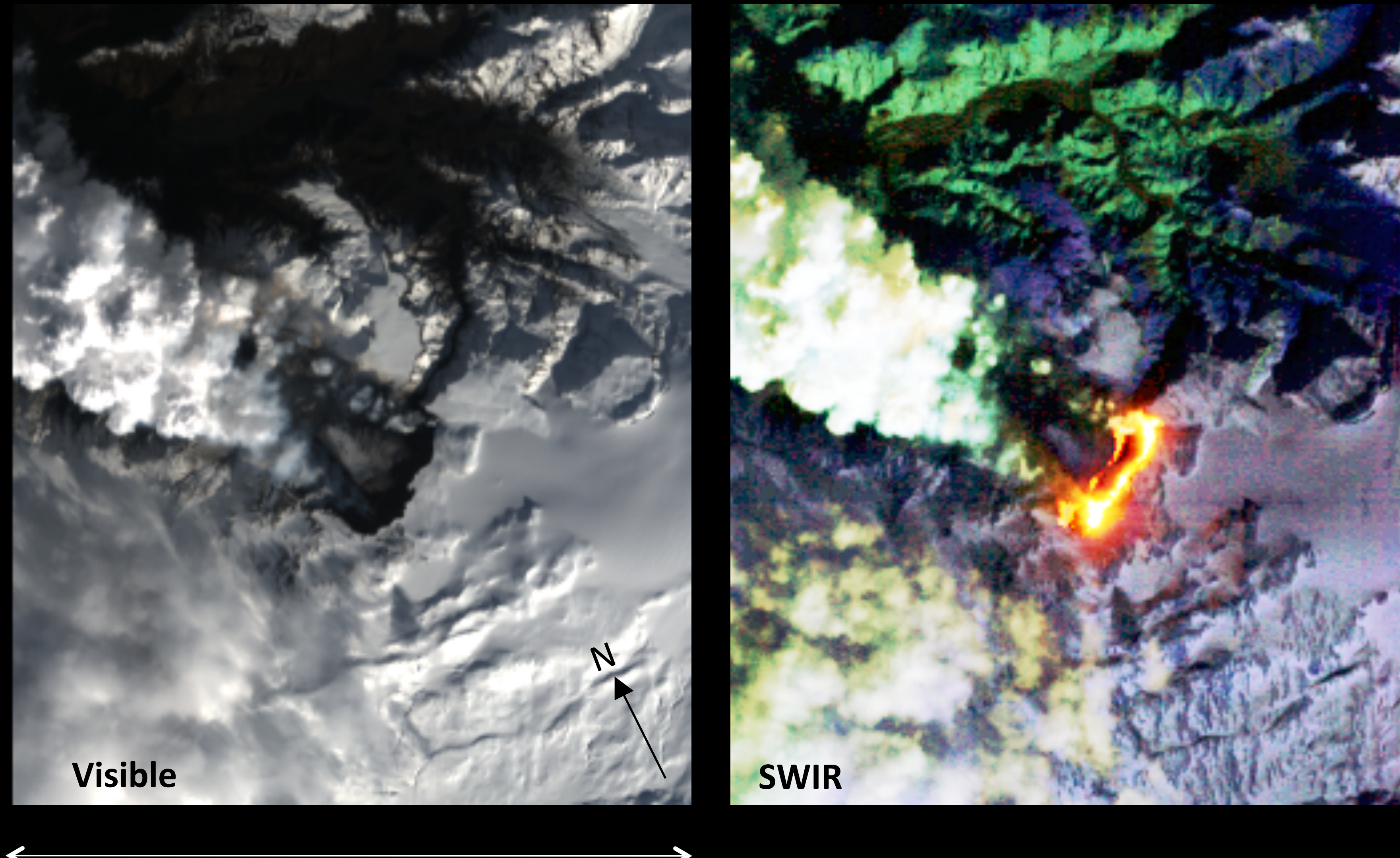
Grey area = saturated

If data saturated at longer wavelengths, shorter wavelengths usable for fitting black-body curves: see Wright *et al.*, Davies *et al.* pubs.

Davies, et al.

24 March 2010

EO1H2180152010083110KF - Hyperion



7.7 km

Davies, et al.

Davies *et al.* (2013) JGR

Lessons learned: 2004-2010

VSW and products are of most value where time is crucial and/or locations are remote/not accessible → Nyamulagira, 2006

The best "customer satisfaction" results from pre-determined agreements with individual end users, because in the middle of a volcanic crisis…

- local authorities work to the plan in place
- time commitment is already 100% - "what's this?"
- it is not clear to whom products should be sent

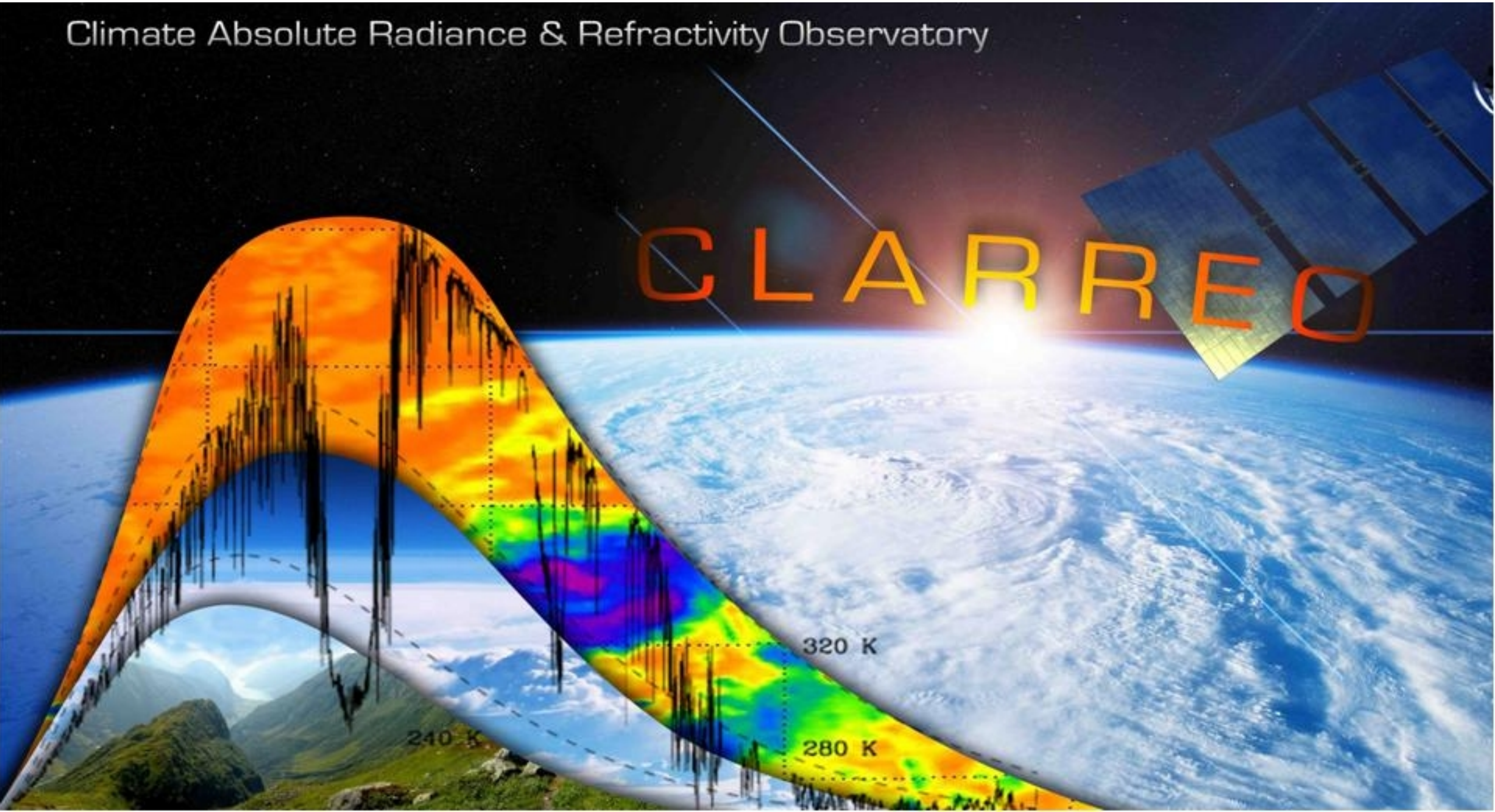
Solution: make products available, and publicise availability

- working to make VSW products widely accessible beyond JPL
- triggering from updates to GVN
- talking endlessly about it → e.g., Pavlof, 16 Nov 2014

GODDARD SPACE FLIGHT CENTER

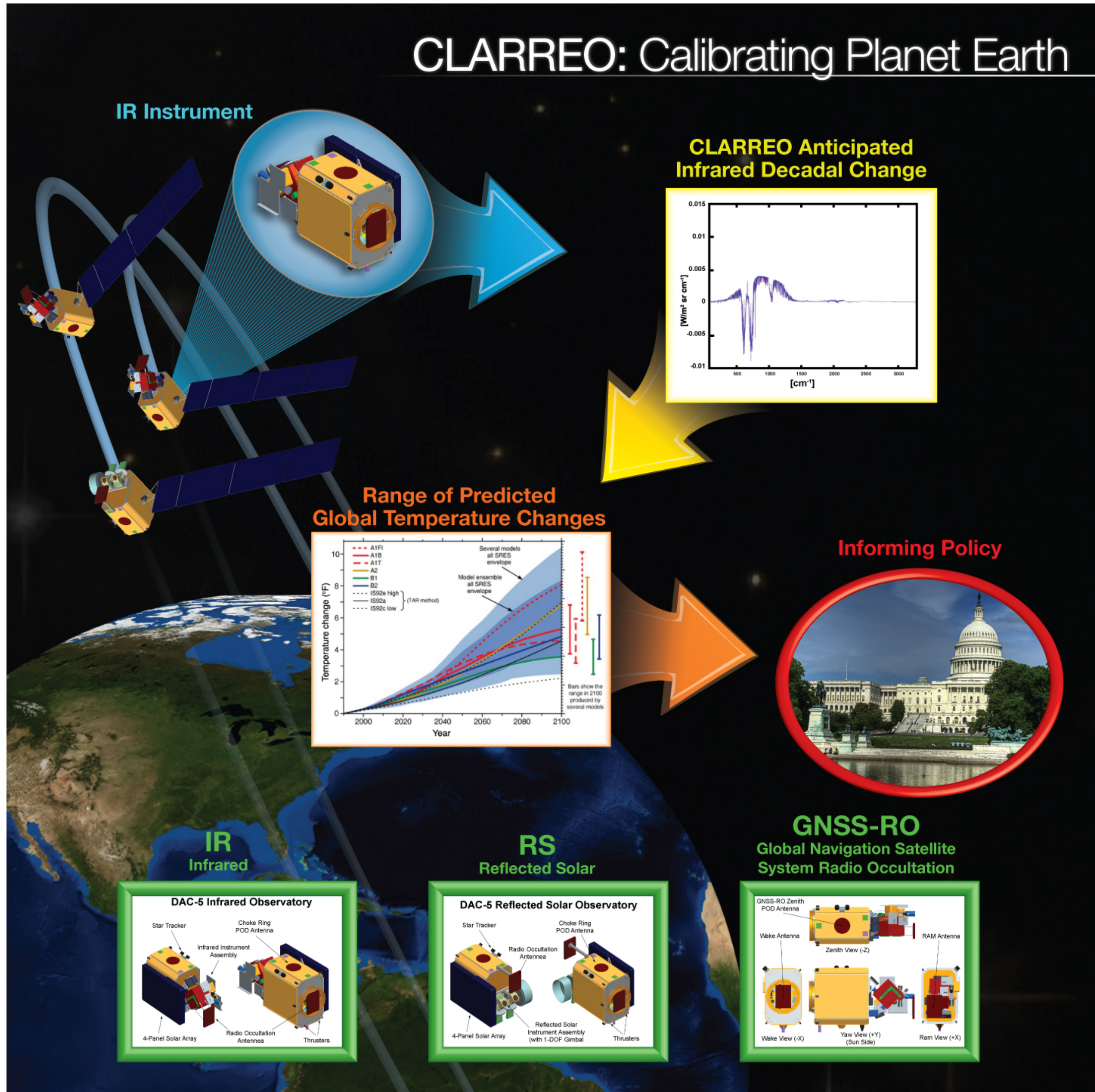
CLARREO ISS Pathfinder

K. Thome
NASA/GSFC



CLARREO Solves the Climate Accuracy Challenge

- Climate Absolute Radiance & Refractivity Observatory
- Insufficient absolute accuracy remains an Achilles Heel for climate change observations
  - Improved accuracy needed for
  - Climate model testing
  - Climate model predictions of future change
  - Societal policy decisions

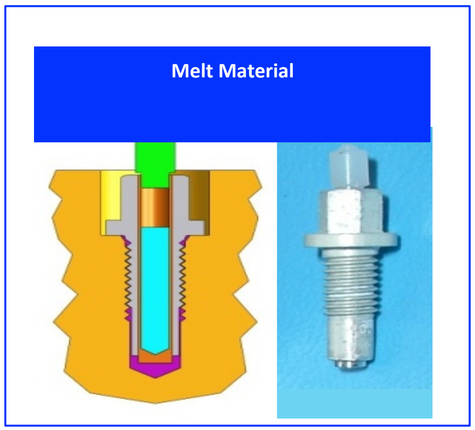


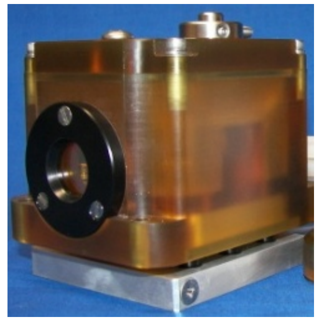
K. Thome

CLARREO Solves the Climate Accuracy Challenge

- Gaps in record would not degrade climate records

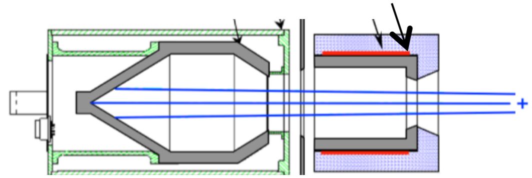
Phase Change Cells

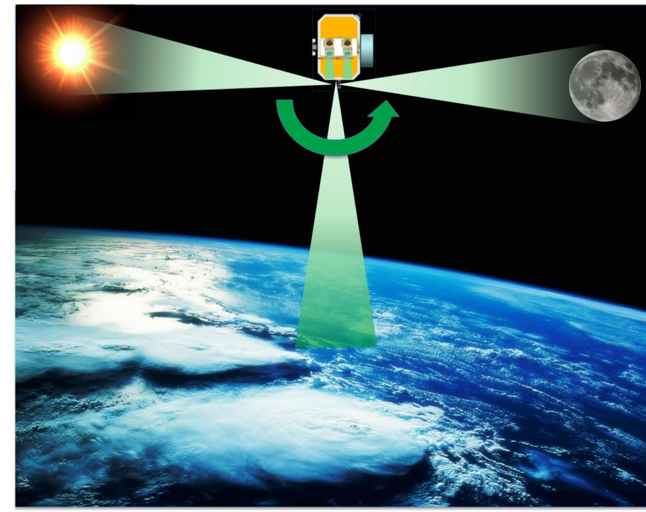




Quantum Cascade Laser (QCL)

Heated Baffle





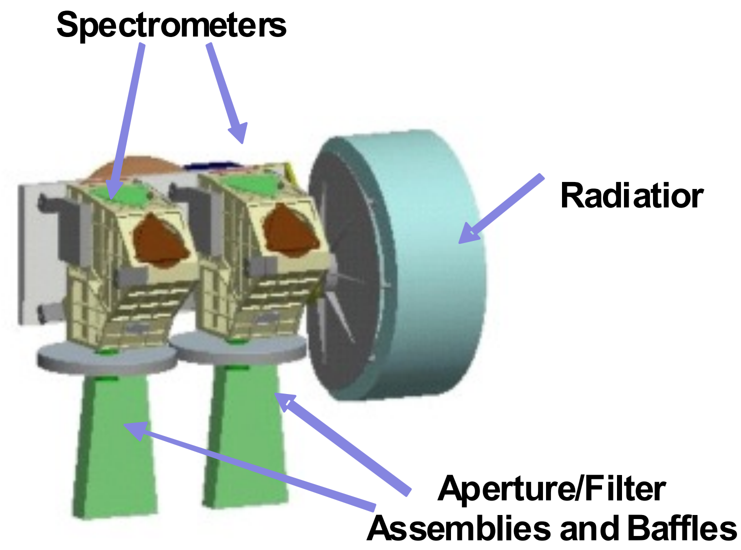
- Accuracy requirements provide observations to allow climate change detection within 20% of perfect observations (0.1K and 0.3% of reflectance k=2)
- CLARREO provides SI traceable high accuracy rigorous measurements of the entire solar and infrared spectrum ("NIST in orbit") to detect long-term climate change trends
  - Approaches based on work of academia, government, and industry
  - Will not require overlapping data records

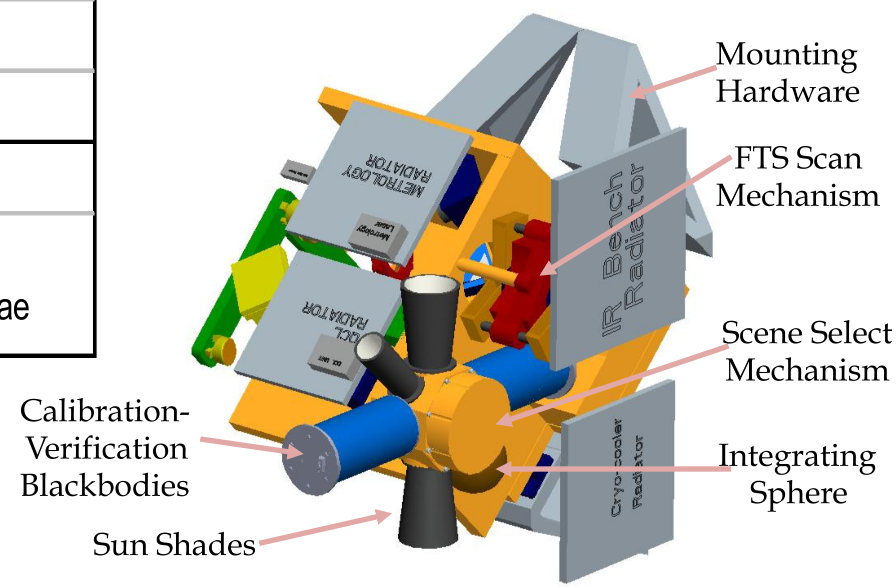
K. Thome

CLARREO Summary

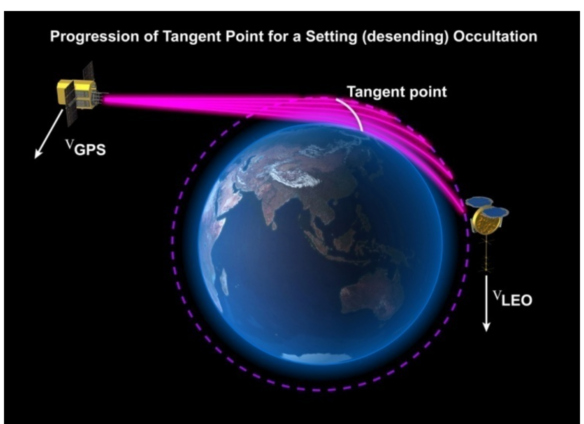
Payload Suite

Instrument	Features	
Infrared Spectrometer	Type	Fourier transform spectrometer
	Spectral Range	5 to 50 micron
	Configuration	Single combined instrument
Reflected Solar Spectrometer	Type	Grating spectrometer
	Spectral Range	320-2300 nanometer
	Configuration	Two box design
GNSS Radio Occultation System	Signal Range	GPS and Galileo
	Configuration	Receiver Two occultation antennae





IR Instrument Concept Design (BB Radiator and Enclosure Partially Removed)



K. Thome

CLARREO Project Update

CLARREO continues in extended pre-phase A with a launch date after 2020

- 2010 - CLARREO passed MCR with no major RFAs and recommended to proceed to Phase A
- 2011 – Budget reductions placed CLARREO into extended pre-phase A
- 2012 – Results on economic value of CLARREO climate science to society: between $3T and $20T (2012 U.S.)
- 2013 – CLARREO presented ISS concept to NASA HQ achieving 73% of baseline mission science for ~35% of original cost
- 2014 – NASA HQ requested Technology Demonstration ideas for ISS
  - Multiple CLARREO groups submitted concepts for RS and IR
  - Revised budget phasing submitted at HQ request
- 2014 – CLARREO develops low cost free-flyer mission concepts
- **2015 – February. President's budget includes a CLARREO Pathfinder line to fly RS and IR on ISS with a 2019 launch**

K. Thome

National Aeronautics and Space Administration

What’s Next?
Planning for the Future

Lisa Callahan
GSFC Earth Sciences Division

Future Missions

- Implementation of the current Earth Sciences Decadal Survey (2007) will not continue past the current set of missions in formulation
  - Missions (and the associated measurements) from the 1st Decadal Survey not currently planned for implementation will be reconsidered in the next Decadal Survey.
    - This includes ACE, HyspIRI, GEOCAPE and ASCENDS
- The second Earth Sciences Decadal Survey will be conducted over the next two years with publication expected in 2017
  - Missions from the 2nd Decadal Survey will launch in the 2023 and beyond timeframe

Planning for the Decadal Survey

- All indications are that the focus for the upcoming DS study will be on high priority science questions and associated measurements as opposed to mission concepts with specific instruments
- Opportunity to participate in DS – nominate yourself (or others): http://tinyurl.com/nzmgozd
- In addition, it is important to develop white papers that capture key science questions and measurements and socialize these papers within your community.

Earth Venture

Other primary opportunity for future missions is within the Earth Venture Program which has three elements:

- Earth Venture – Suborbital
  - $30M Cap with 5 year duration
  - AO every 4 years – next AO expected ~ 2017
- Earth Venture Instruments
  - Class C ($94M Cap) and Class D ($30M Cap)
  - AO every 18 months
    - ~ Feb 2015, EV-I (3)
    - ~ August 2017, EV-I (4)
- Earth Venture Missions
  - Class D ($166M Cap FY18$)
  - AO every 4 years – next AO expected ~ July 2015

Future Opportunities Summary

Planning for the future:

•Focus on critical science questions and measurements – what have you learned since 2007 to should inform where your science should be in 2030. THINK BIG

•Decadal Survey opportunities will be limited – Earth Venture may be the more realistic path forward even with less than 100 percent of the desired science.

•Take advantage of the strong applications aspect and community support for anticipated HyspIRI data products and build that into a winning proposal

•Seek to establish and nurture partnerships with industry, academia, NGO, Government and international organizations

ESAS 2017
The 2017-2027 NRC Decadal Survey for Earth Science and Applications from Space

Arthur Charo, Ph.D.
Senior Program Officer
Space Studies Board

HyspIRI Science Symposium

June 4, 2015

Primary Elements of the SOT

- Assess progress in addressing the major scientific and application challenges outlined in the 2007 Earth Science Decadal Survey.
- Develop a prioritized list of top-level science and application objectives to guide space-based Earth observations over a 10-year period commencing approximately at the start of fiscal year 2018 (October 1, 2017).
- Identify gaps and opportunities in the programs of record at NASA, NOAA, and USGS in pursuit of the top-level science and application challenges—including space-based opportunities that provide both sustained and experimental observations.
- Recommend approaches to facilitate the development of a robust, resilient, and appropriately balanced U.S. program of Earth observations from space. Consider: Science priorities, implementation costs, new technologies and platforms, interagency partnerships, international partners, and the *in situ* and other complementary programs carried out at NSF, DoE, DoA, DoD.

A. Charo

Agency-Specific Tasks

NASA

•Recommend NASA research activities to advance Earth system science and applications by means of a set of prioritized strategic "science targets" for the space-based observation opportunities in the decade 2018-2027. (A science target in this instance comprises a set of science objectives that could be pursued and significantly advanced by means of a space- based observation.) …… For each science target, the committee will identify a set of objectives and measurement requirements/capabilities for space-based data acquisitions.

If appropriate and usually only for recommendations associated with major investments, the committee will (via a "CATE" process) assemble notional proof-of-concept missions with the recommended capabilities in order to better understand the top-level scientific performance and technical risk options associated with mission development and execution.

•Other NASA tasks include: The committee will pay particular attention to prioritizing and recommending balances among the full suite of Earth system science research, technology development, flight mission development and operation, and applications/capacity building development conducted in the Earth Science Division (ESD) of the Science Mission Directorate.

Agency-Specific Tasks of the Draft SOT

NOAA & USGS

- The decadal survey committee's recommendations will be framed around national needs, including, but not limited to research priorities. …. Recommendations may be organized around 1) how new technology may enhance current operations, and 2) what new science is needed to expand current operations, either to enable new capabilities or to include new areas of interest. In making these recommendations, the committee will consider the need to bridge current operations and support a viable path forward for the uninterrupted delivery of public services through these generational changes.

- Other tasks include: suggest approaches for evaluating and integrating new capabilities from non traditional suppliers of Earth observations; may offer recommendations concerning "research to operations" (or "innovation for continuity and service improvements across agencies"); and consider the agencies' ability to replicate existing technologies to improve and sustain operational delivery of public services.

A. Charo

What Happens to Missions Recommended in the Previous Survey?

- TBD, but:
- In developing its recommendations, survey to "include reconsideration of the scientific priorities associated with the named missions from the 2007 decadal survey."
  - The 2007 survey did not prioritize among the 15 missions for NASA; placement in 1 of 3 time periods (Tiers I, II, III: 2010-13, 2013-2016, 2016-2020) was based on factors including technical readiness; cost; synergy with existing, planned, or recommended missions; and consideration of int'l activities.
- ESD has expressed an interest in having the survey provide guidance on technology investments that will be needed to address recommended science targets.
- Previous surveys have assumed missions in formulation to be considered part of the baseline program of record.

A. Charo

HyspIRI Aquatic Studies Group
3rd Annual Aquatic Forum

Kevin Turpie
UMBC/JCET GSFC
kturpie@umbc.edu

HyspIRI Symposium
Goddard Space Flight Center
Greenbelt, MD 5 June 2015

HyspIRI Aquatic Studies Group (HASG)

- **The HASG was established to support the HyspIRI coastal and inland aquatic remote sensing community, compiling community input regarding data products, science and applications to formulate recommendations and guidance to NASA and the HyspIRI mission.**

- Established in 2012 through support by NASA HQ and Goddard Space Flight Center.

- The group has grown to 70+ participants, affiliated with **international** and **domestic** institutions, including government, university, research or application organizations.

- If you are interested in participating in the HASG, please contact Kevin Turpie (kevin.r.turpie@nasa.gov).

HASG White Paper now a NASA STI TM

NASA/TM–2015-217530

Coastal and Inland Aquatic Data Products for the Hyperspectral Infrared Imager (HyspIRI)

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Naval Research Laboratory

Marcel Babin
Unité Mixte Internationale Takuvik, Université Laval

Charles Bachmann
Rochester Institute of Technology

Thomas Bell
University of California at Santa Barbara

Vittorio Brando
IREA, Consiglio Nazionale delle Ricerche

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U.S. Geological Survey

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April 2015