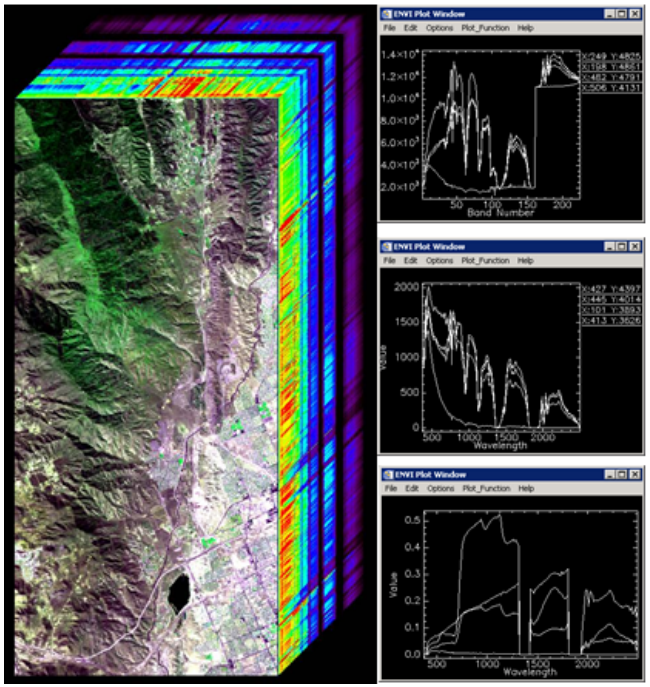
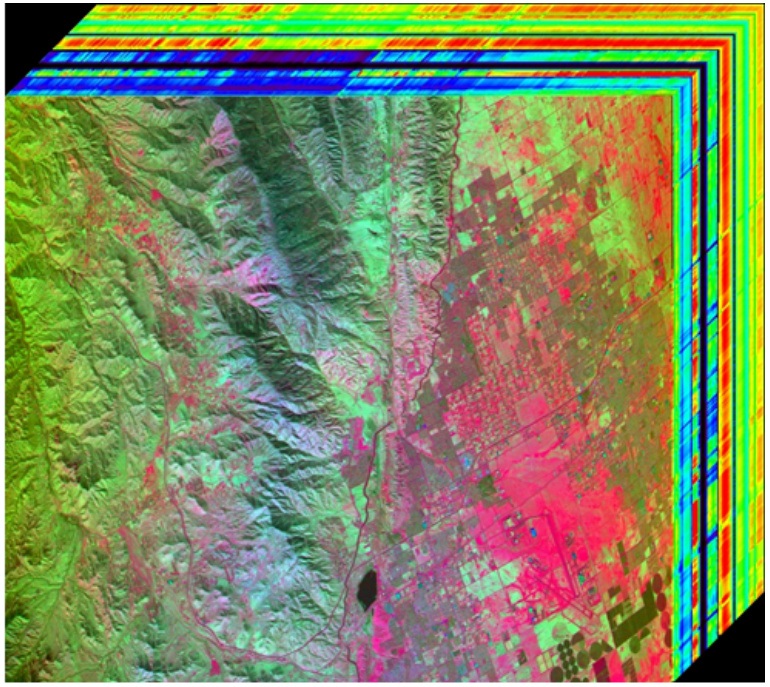
HyspIRI Preparatory Airborne Campaign





Robert O. Green, Ian McCubbin, Simon Hook, and the Airborne Campaign Team

Jet Propulsion Laboratory, California Institute of Technology

HyspIRI Decadal Survey Mission

Key Science and Science Applications

Climate: Ecosystem biochemistry, condition & feedback; spectral albedo; carbon/dust on snow/ice; biomass burning; evapotranspiration

Ecosystems: *Global* biodiversity, plant functional types, physiological condition, and biochemistry including agricultural lands

Fires: Fuel status; fire frequency, severity, emissions, and patterns of recovery *globally*

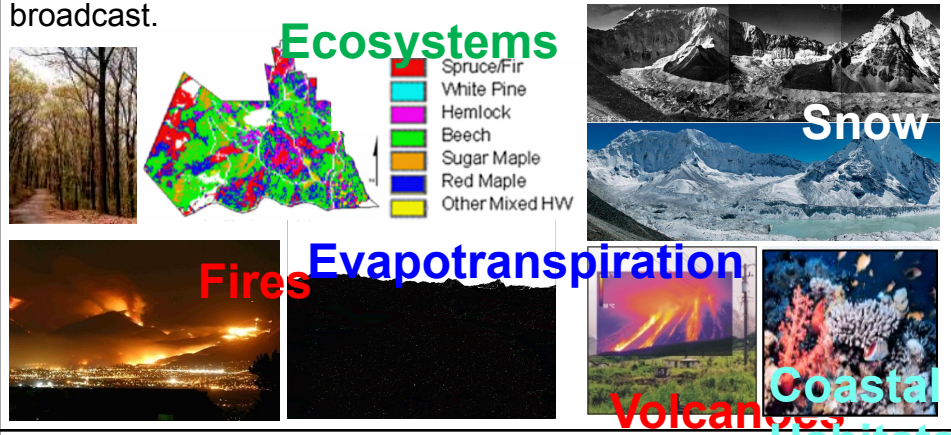
Coral reef and coastal habitats: *Global* composition and status

Volcanoes: Eruptions, emissions, regional and *global* impact

Geology and resources: *Global* distributions of surface mineral resources and improved understanding of geology and related hazards

Mission Urgency

The HyspIRI science and applications objectives are critical today and uniquely addressed by the combined imaging spectroscopy, thermal infrared measurements, and IPM direct broadcast.



Measurement

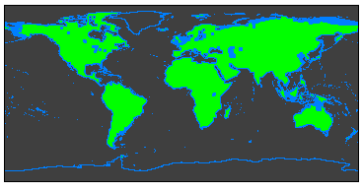
Imaging Spectrometer (VSWIR)

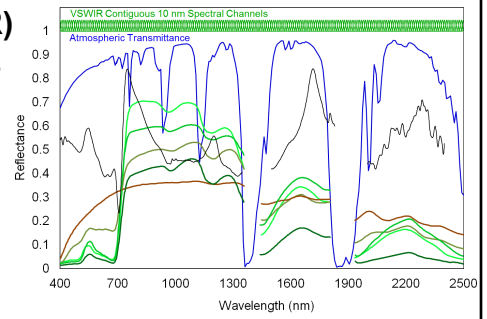
- 380 to 2500nm in 10nm bands
- 60 m spatial sampling
- 19 days revisit
- Global land and shallow water

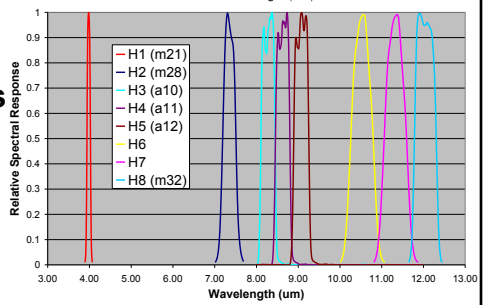
Thermal Infrared (TIR):

- 8 bands between 4-12 µm
- 60 m spatial sampling
- 5 days revisit; day/night
- Global land and shallow water

IPM-Low Latency data subsets







Mission Concept Status

Level 1 Measurement Requirements: Vetted by community and stable

Payload: **VSWIR** Imaging Spectrometer, **TIR** Imaging radiometer, and **IPM**-Low Latency subsets

Full Mission option: Baseline mission mature with Aerospace Independent Cost Estimate ($493M to $647M in FY12$)

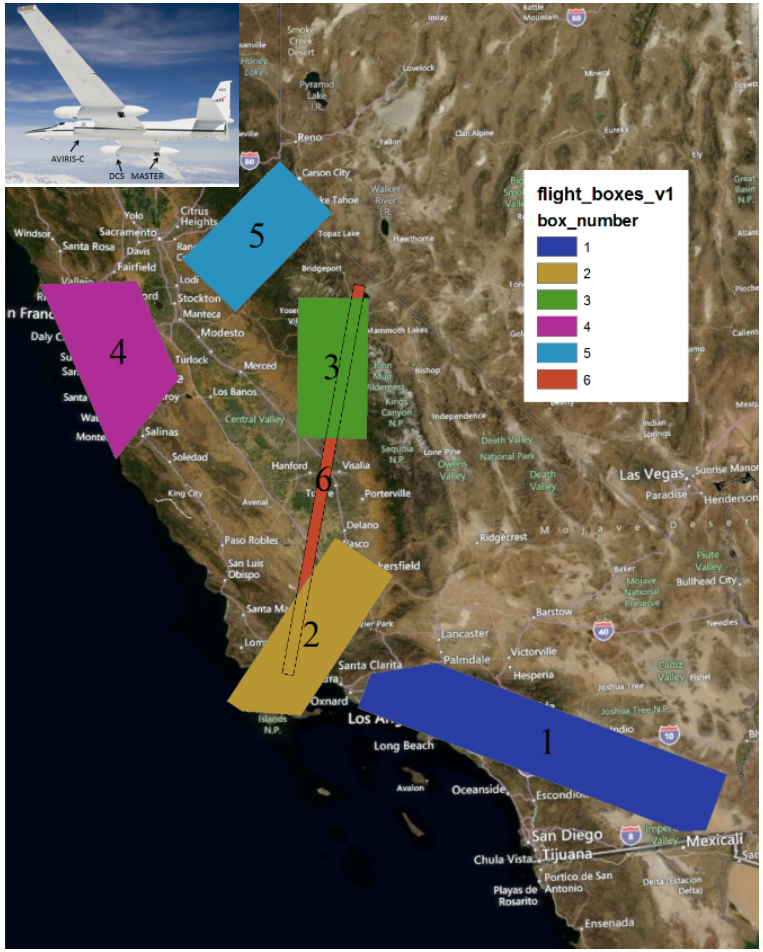
Options for Technology/Science ISS Demonstration: Submitted for VSWIR and TIR with IPM

Studies for instrument on separate platforms: Draft Science whitepaper underway

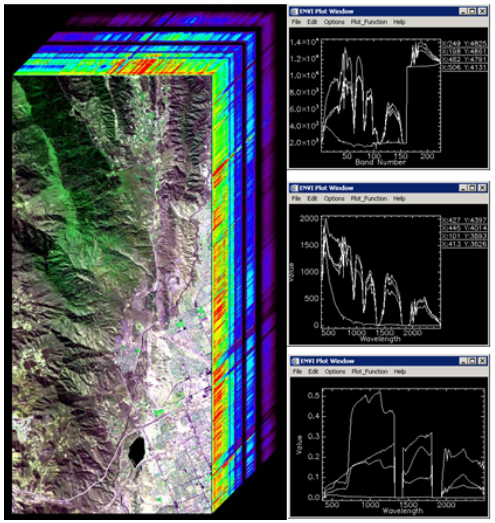
Summary: The HyspIRI mission measurement requirements and baseline instruments approach are mature and stable with good heritage, low risk and modest cost. Now exploring a range of instrument and data options to save cost, per guidance letter.

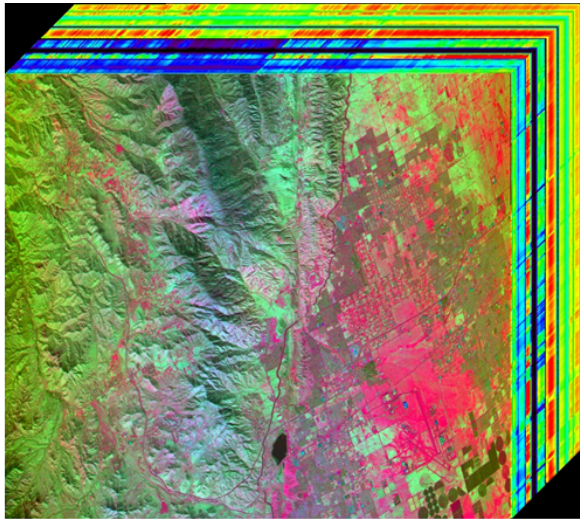
Overview

- R&A HyspIRI Preparatory Airborne Campaign
  - science team with 14 PIs
  - Delivered Level 1 and Level 2 data products
- Ecosystems, Seasonal, Climate, Coastal, Urban, Resources
- 6 zones, 3 seasons, 2 years



- Objective: Advance HyspIRI Mission Science and Algorithm Readiness
  - *Ecosystem composition, function, biochemistry, seasonality, structure, and modeling*
  - *Coastal ocean phytoplankton functional types, habitat*
  - *Urban land cover, temperature, transpiration*
  - *Surface energy balance*
  - *Atmospheric characterization and local methane sources*
  - *Surface geology, resources, soils, hazards*

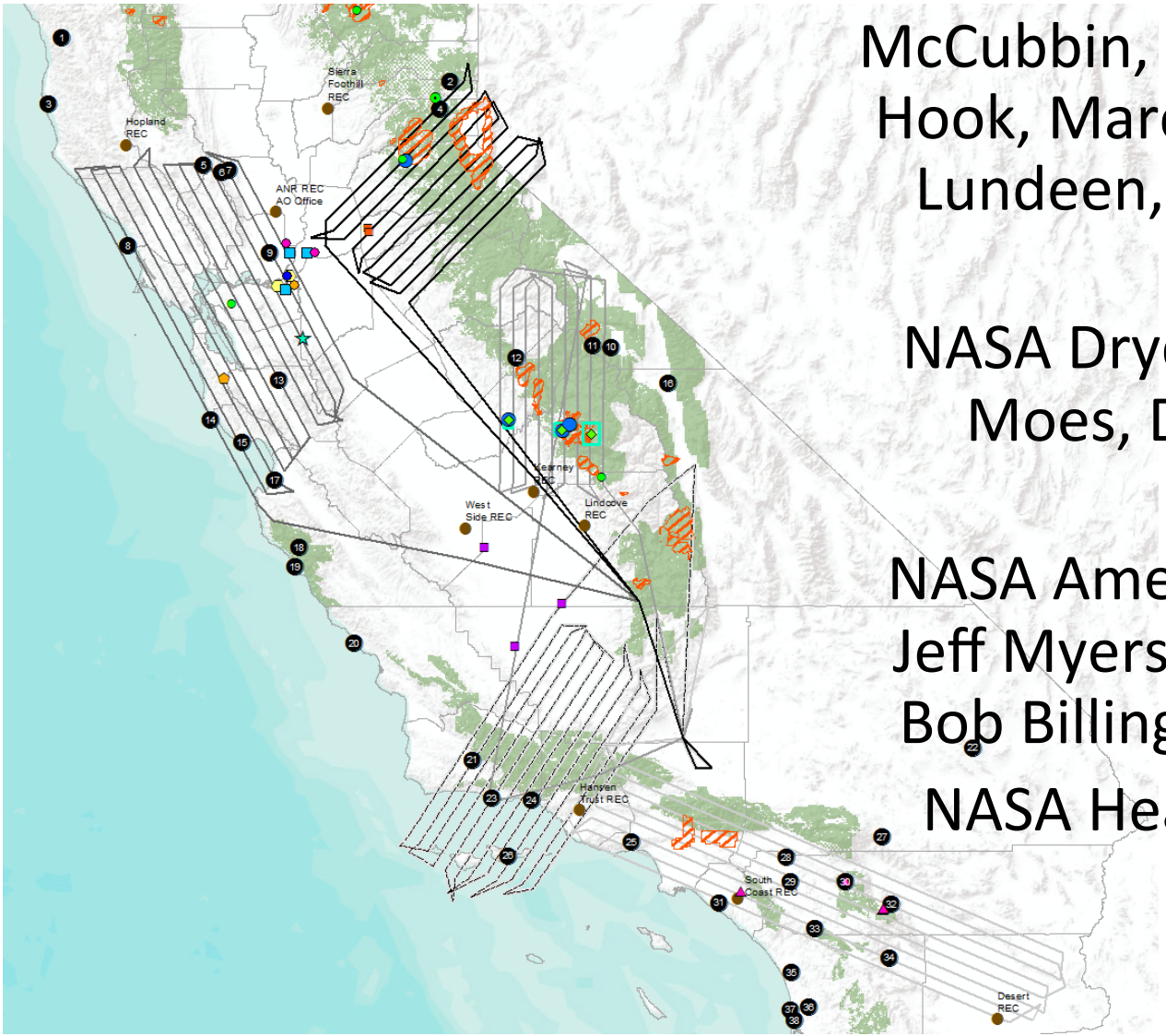




HyspIRI Preparatory Airborne Studies

- Harvard/Paul Moorcroft - Linking Terrestrial Biosphere Models with Imaging Spectrometry Measurements of Ecosystem Composition, Structure, and Function
- UC Santa Barbara/Dar Roberts - HyspIRI discrimination of plant species and functional types along a strong environmental-temperature gradient
- UWI/Philip Townsend - Measurement of ecosystem metabolism across climatic and vegetation gradients in California for the 2013-2014 NASA AVIRIS/MASTER airborne campaign
- UC Davis/Susan Ustin - Identification of Plant Functional Types By Characterization of Canopy Chemistry Using an Automated Advanced Canopy Radiative Transfer Model
- Sonoma State/Matthew Clark - Spectral and temporal discrimination of vegetation cover across California with simulated HyspIRI imagery
- NRL/Bo-Cai Gao - Characterization and Atmospheric Corrections to the AVIRIS-Classic and AVIRISng Data to Support the HyspIRI Preparatory Airborne Activities
- USGS/Bernard Hubbard - Using simulated HyspIRI data for soil mineral mapping, relative dating and flood hazard assessment of alluvial fans in the Salton Sea basin, Southern California
- UC Riverside/George Jenerette - Assessing Relationships Between Urban Land Cover, Surface Temperature, and Transpiration Along a Coastal to Desert Climate Gradient
- NEON/Thomas Kampe - Synergistic high-resolution airborne measurements of ecosystem structure and process at NEON sites in California
- UC Santa Cruz/Raphael Kudela - Using HyspIRI at the Land/Sea Interface to Identify Phytoplankton Functional Types
- Bubbleology/Ira Leifer - Hyperspectral imaging spectroscopic investigation of California natural and anthropogenic fossil methane emissions in the short-wave and thermal infrared
- UMD/Shunlin Liang - Characterizing surface energy budget of different surface types under varying climatic conditions from AVIRIS and MASTER data
- RIT/Jan van Aardt - Investigating the impact of spatially-explicit sub-pixel structural variation on the assessment of vegetation structure from HyspIRI data
- UNV/Wendy Calvin - Energy and Mineral Resources: Surface composition mapping that identifies resources and the changes and impacts associated with their development

HyspIRI Airborne Preparatory Mission



Jet Propulsion Lab: Ian McCubbin, Robert Green, Simon Hook, Marco Hernandez, Sarah Lundeen, Scott Nolte, Chuck Sarture

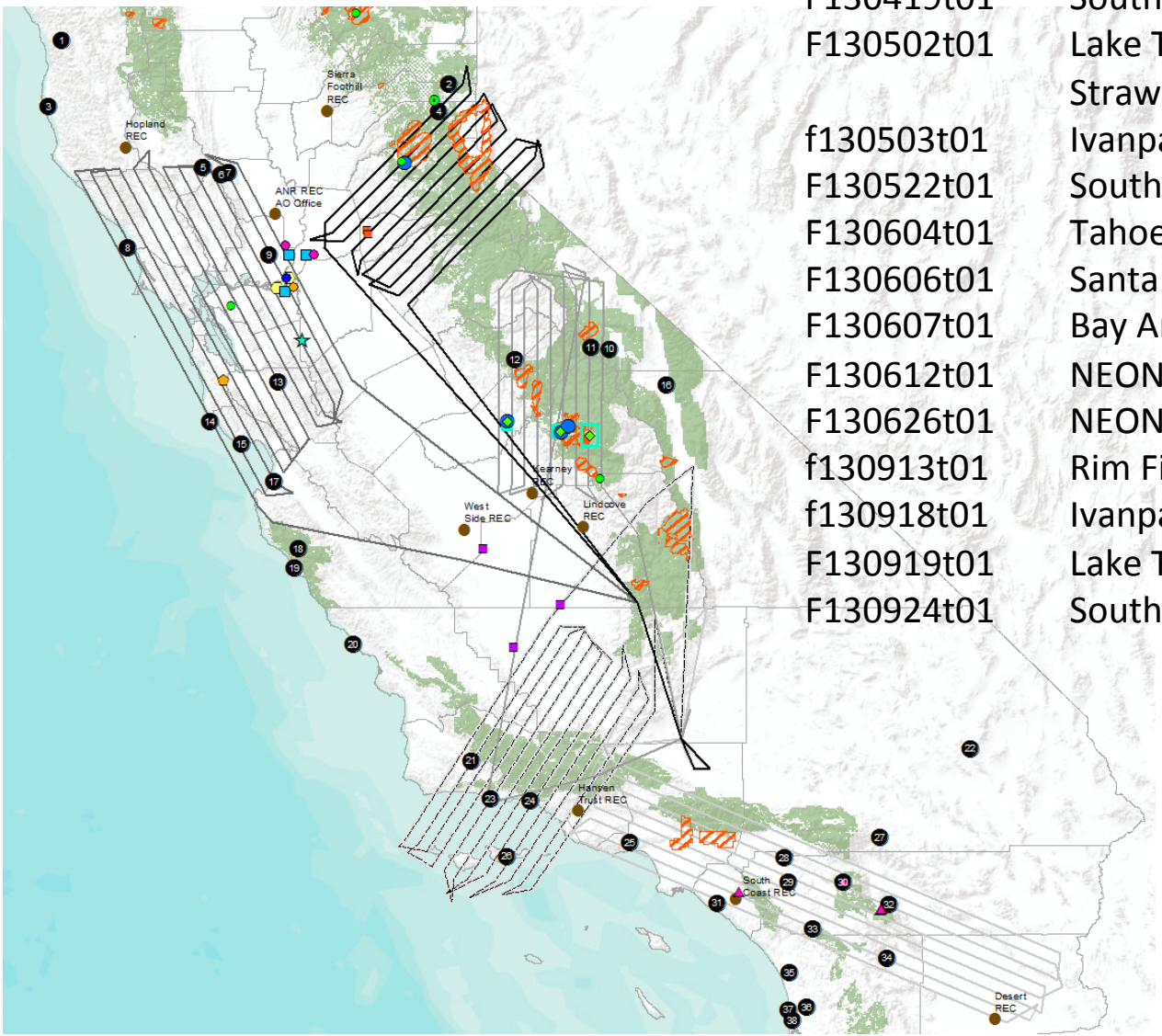
NASA Dryden: Stu Broce, Tim Moes, Dean Neeley, Tim Williams

NASA Ames: Rose Dominguez, Jeff Myers, Dennis Gearherdt, Bob Billings, Kent Dunwoody,

NASA Headquarters Woody Turner

HyspIRI Airborne Preparatory Mission

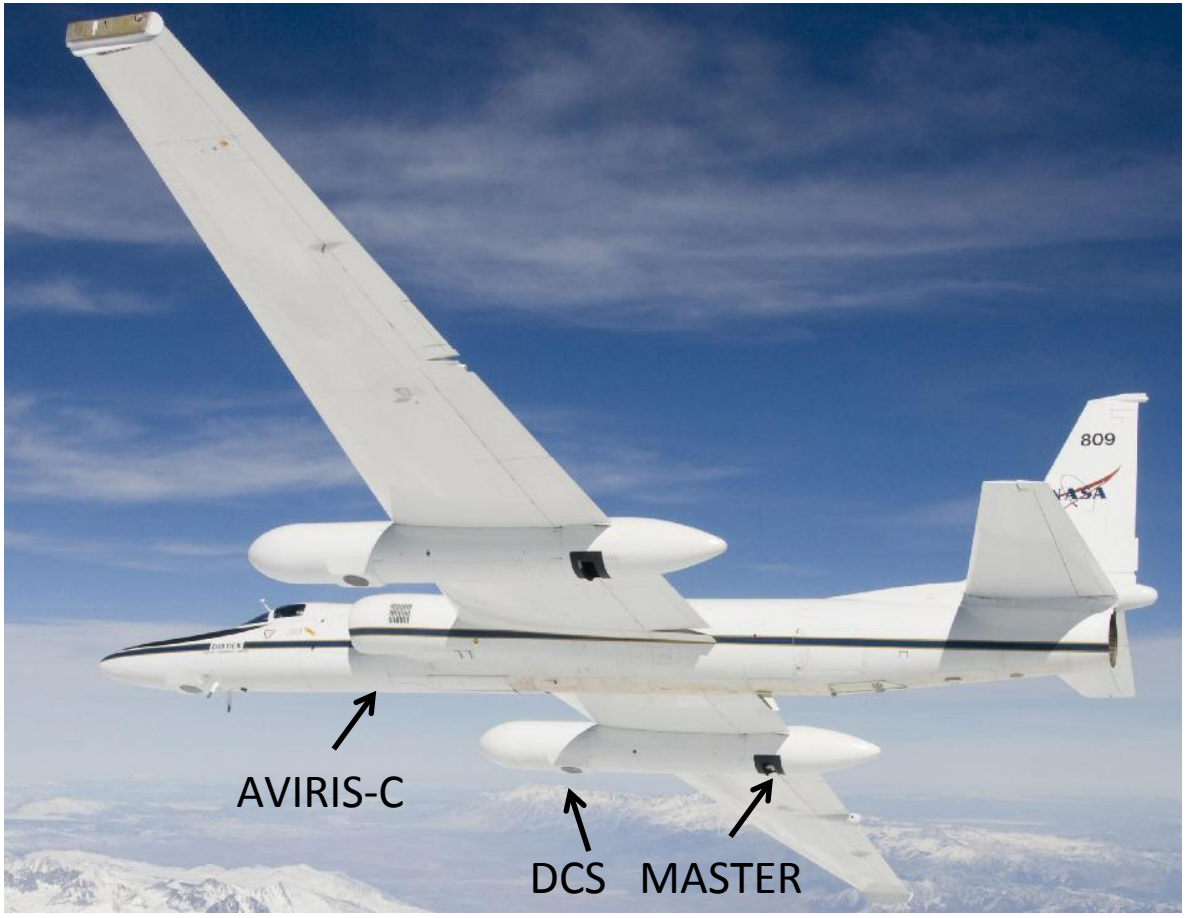
F130410t01	San Francisco Bay Area, CA
F130411t01	Santa Barbara, CA
F130412t01	Southern California Box no MASTER
F130419t01	Southern California Box
F130502t01	Lake Tahoe Box, MASTER calibration, Soda Straw, Landsat 8 Delta Overpass
f130503t01	Ivanpah, Mtn Pass and Yosemite-NEON, CA
F130522t01	Southern California Box
F130604t01	Tahoe Box, CA
F130606t01	Santa Barbara, CA
F130607t01	Bay Area Box, CA
F130612t01	NEON/Yosemite Box
F130626t01	NEON/Yosemite Box
f130913t01	Rim Fire Portion of NEON/Yosemite Box, CA
f130918t01	Ivanpah Calibration Experiment
F130919t01	Lake Tahoe Box
F130924t01	Southern California Box



HyspIRI Airborne Preparatory Mission

AVIRIS and MASTER on ER-2 with 3 Seasonal Flights in 2013 and 2014 Datasets to Simulate Future HyspIRI Satellite Flights Over California Based from NASA Dryden

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



2013 Dates:

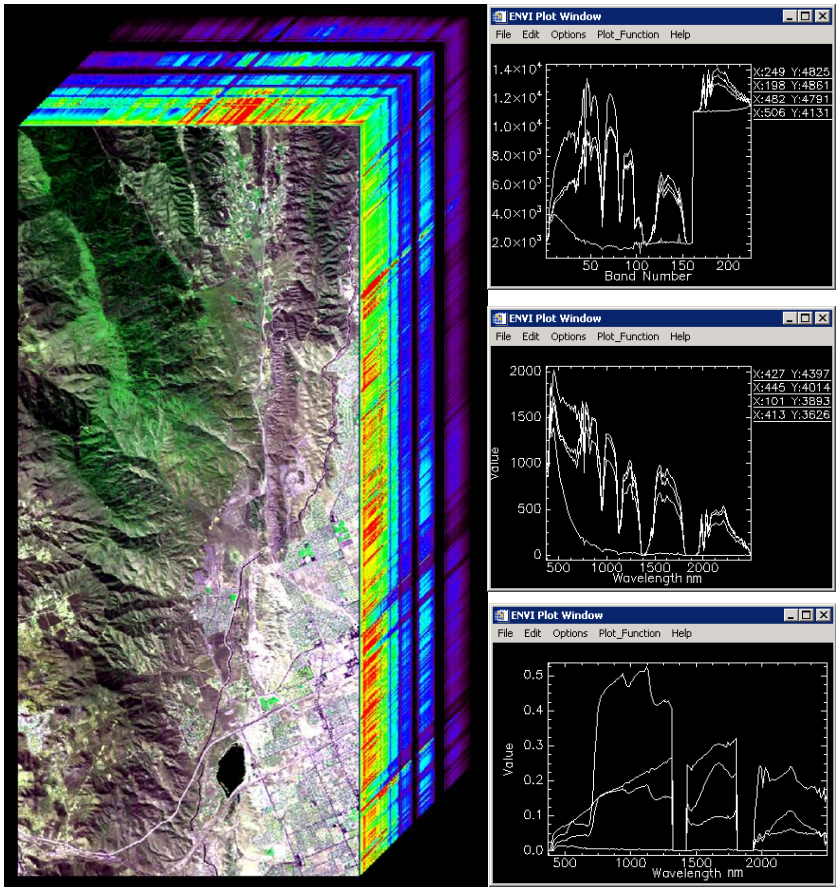
1. Mar 20 - April 22
2. May 22 - June 10
3. Fall Flights
   A. Sept 9 – 20
   B. Oct/Nov TBD

PI TEAM:
Wendy Calvin/University of Nevada - Reno
Matthew Clark/Sonoma State University
Bo-Cai Gao/Naval Research Laboratory
Bernard Hubbard/U. S. Geological Survey
George Jenerette/University of California, Riverside
Thomas Kampe/National Ecological Observatory Network
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

HyspIRI Airborne Preparatory Mission

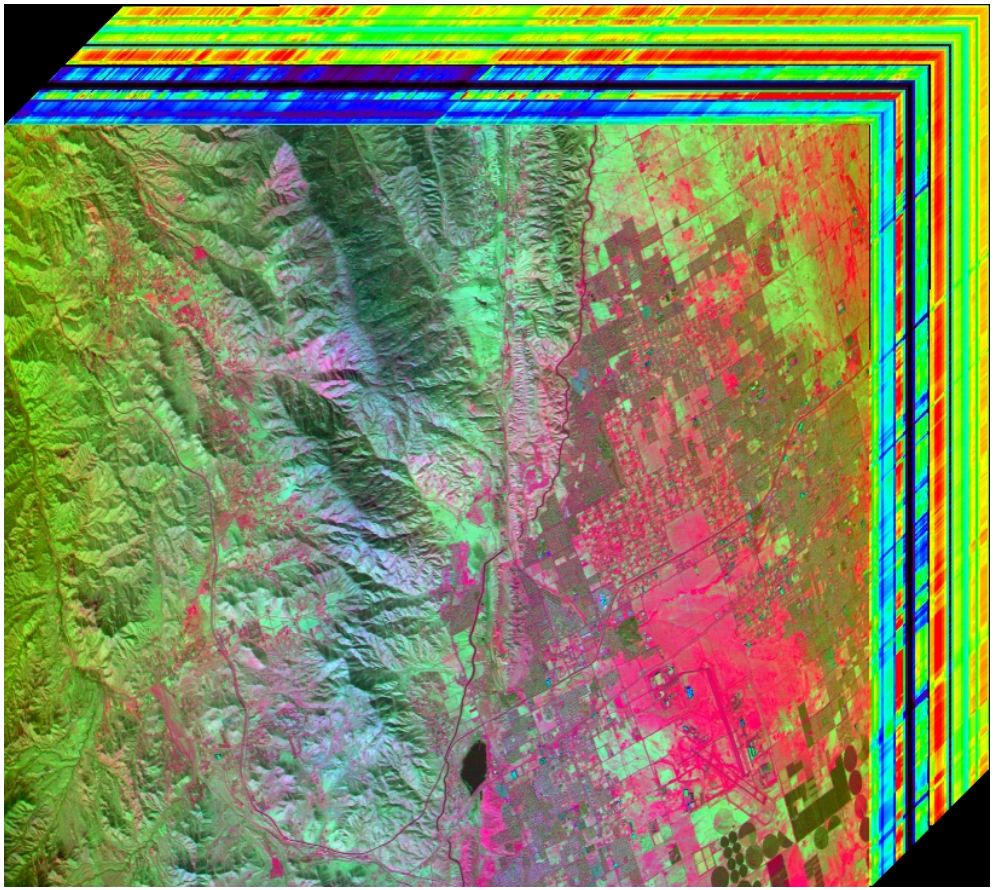
First HyspIRI Test Flights March 29, 2013, Palmdale CA

AVIRIS



AVIRIS image cube and Level 1a, 1b and 2 spectra. The reflectance spectra (L2) will be used to address the full range of science objectives including ecosystems and climate.

MASTER

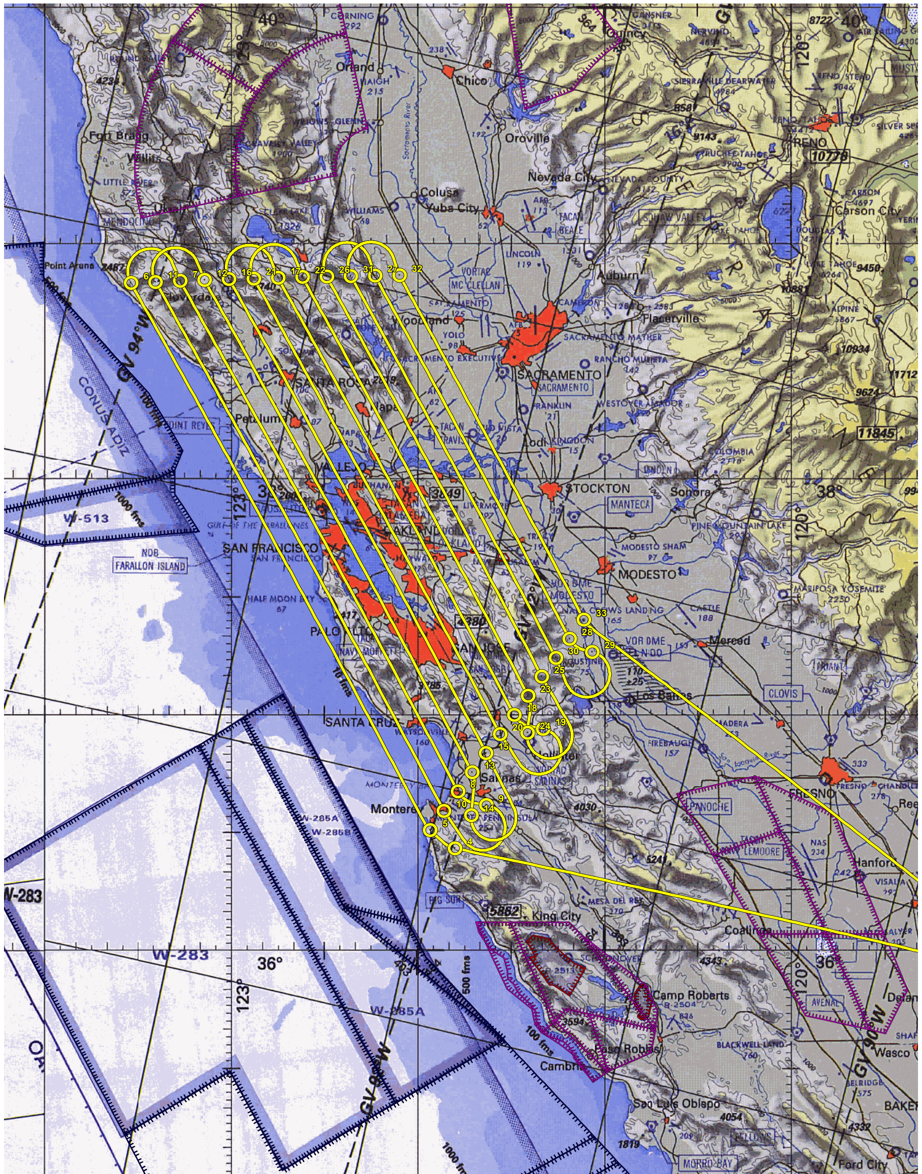


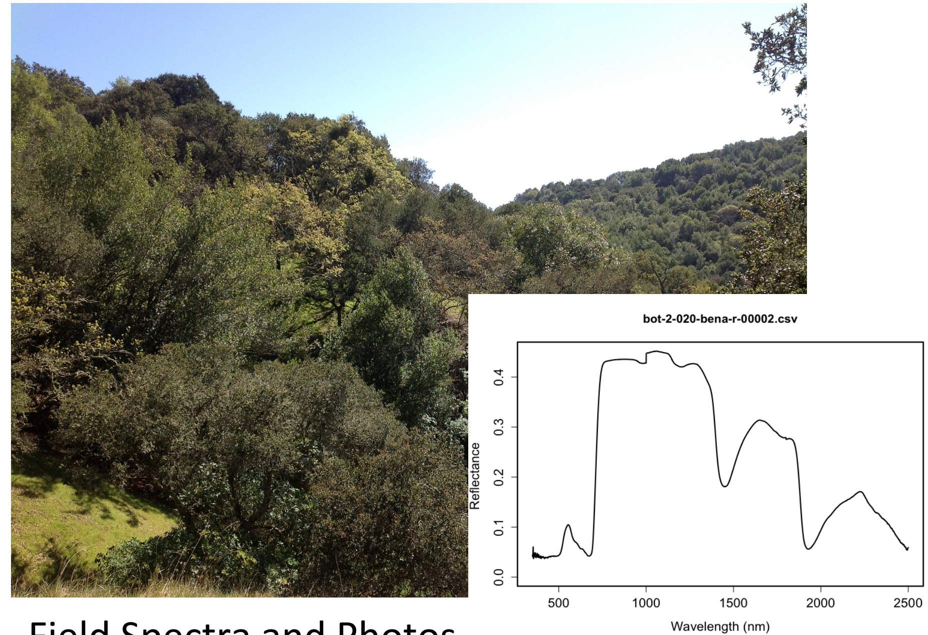
MASTER image cube. Temperature information is shown as color intensity and mimics topography and composition (emissivity) information is shown as color. Red areas are composed of minerals with high silica such as urban areas Water and heavily vegetated areas are dark indicating they are cooler. HyspIRI temperature and composition information are key to addressing a range of objectives.

April 10, 2013 – San Francisco Bay - 6.5 hours

UCSC and Ames Team on R/V Martin in Monterey Bay – Sonoma State in Bay Area

UCD in Sacramento Delta



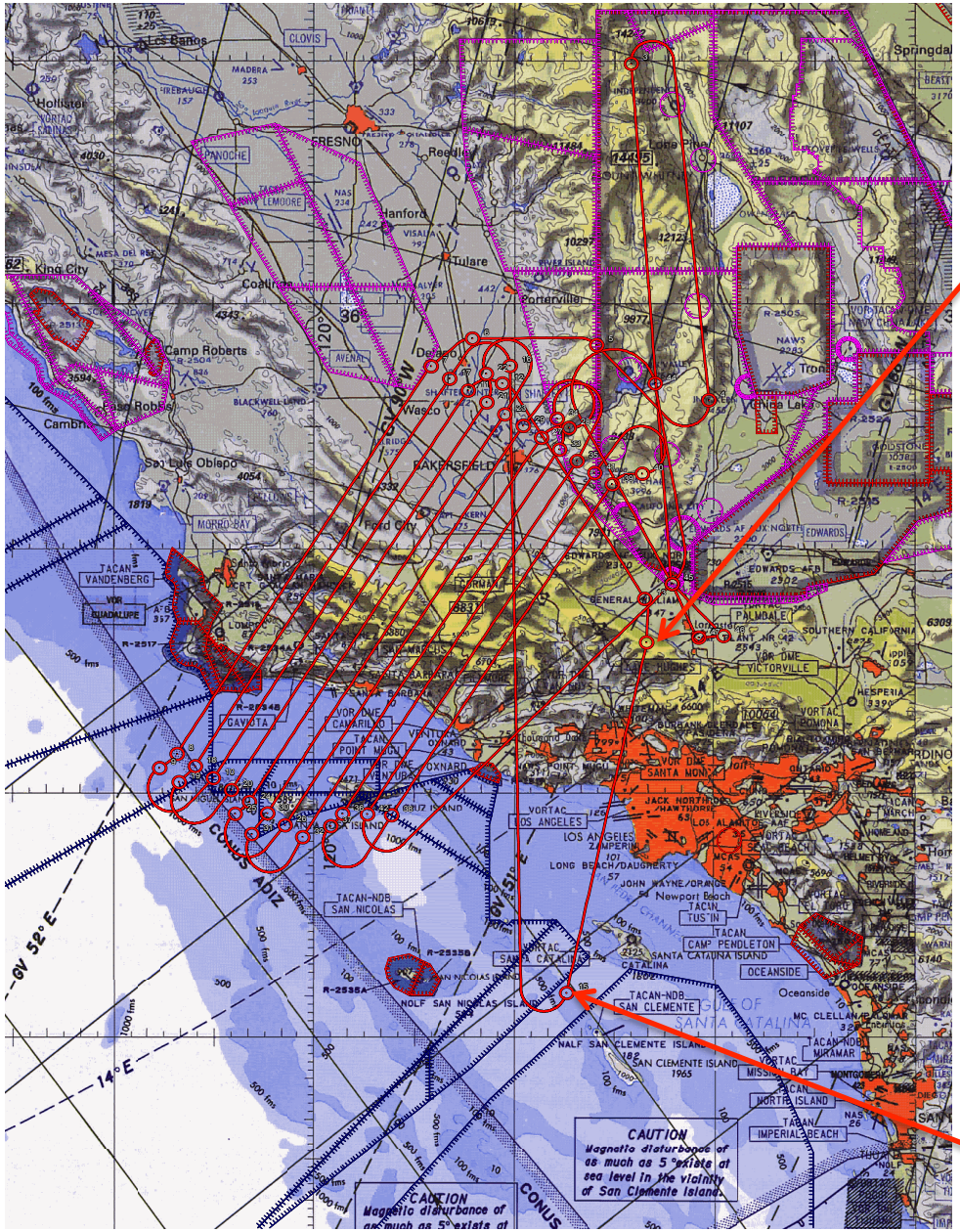


Field Spectra and Photos
from Sonoma State and Wisconsin

R/V Martin used by UCSC/Ames Ocean Remote Sensing Team at Monterrey Bay

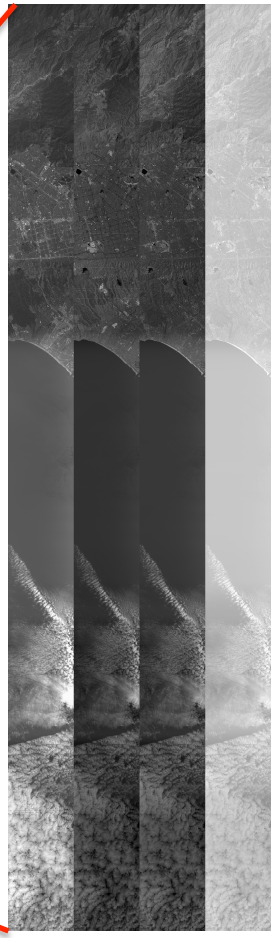
April 11, 2013 – Santa Barbara Box - 4.1 hours

Landsat 8 Under-flight over Los Angeles



NASA/NOAA UCSB Plumes and Blumes Cruise in SB Channel During Overflight

AVIRIS Data



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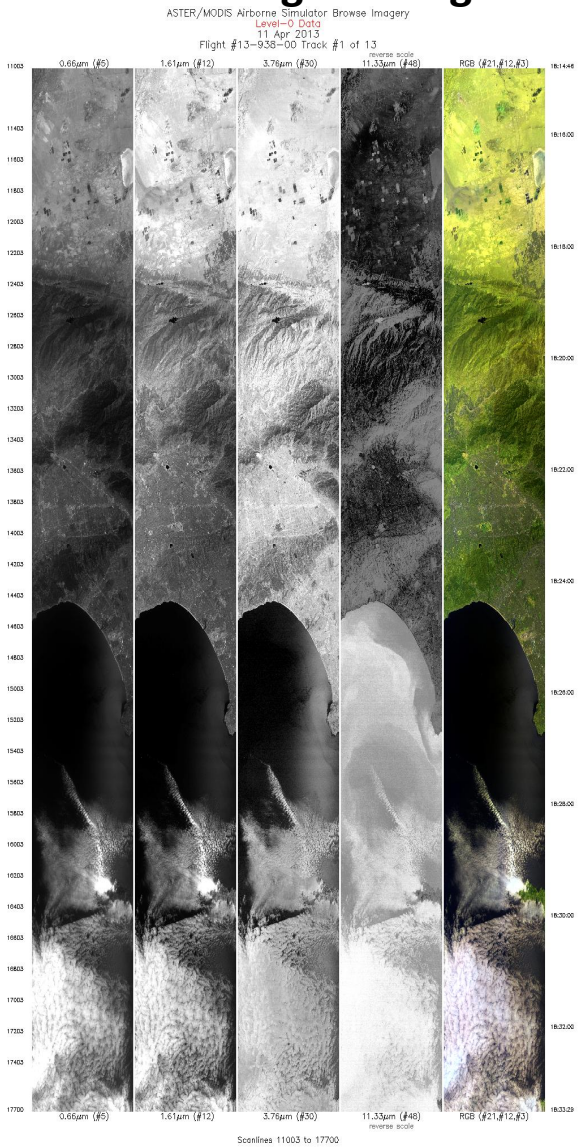
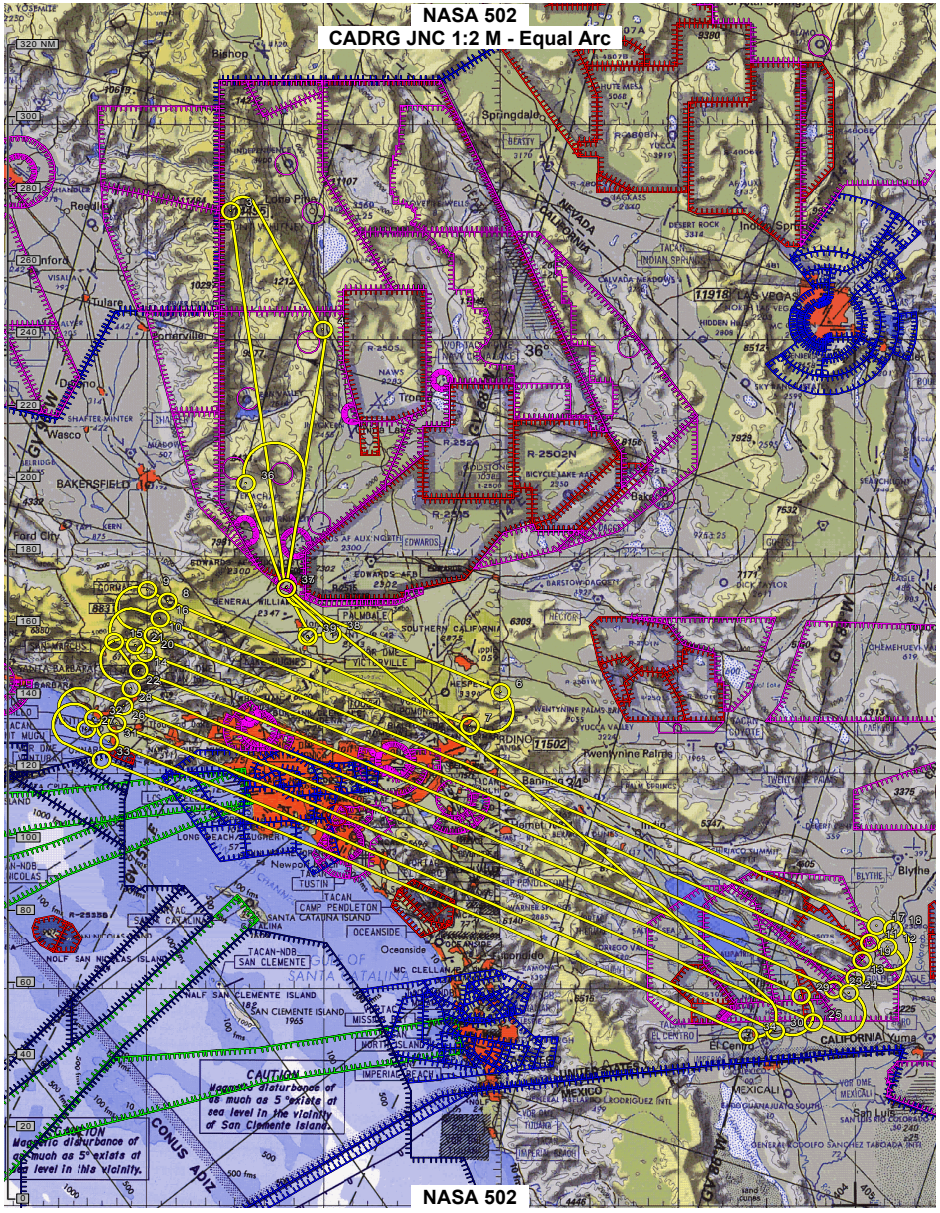


MASTER Data

April 19, 2013 – Southern California Box

7.6 hour Flight Time

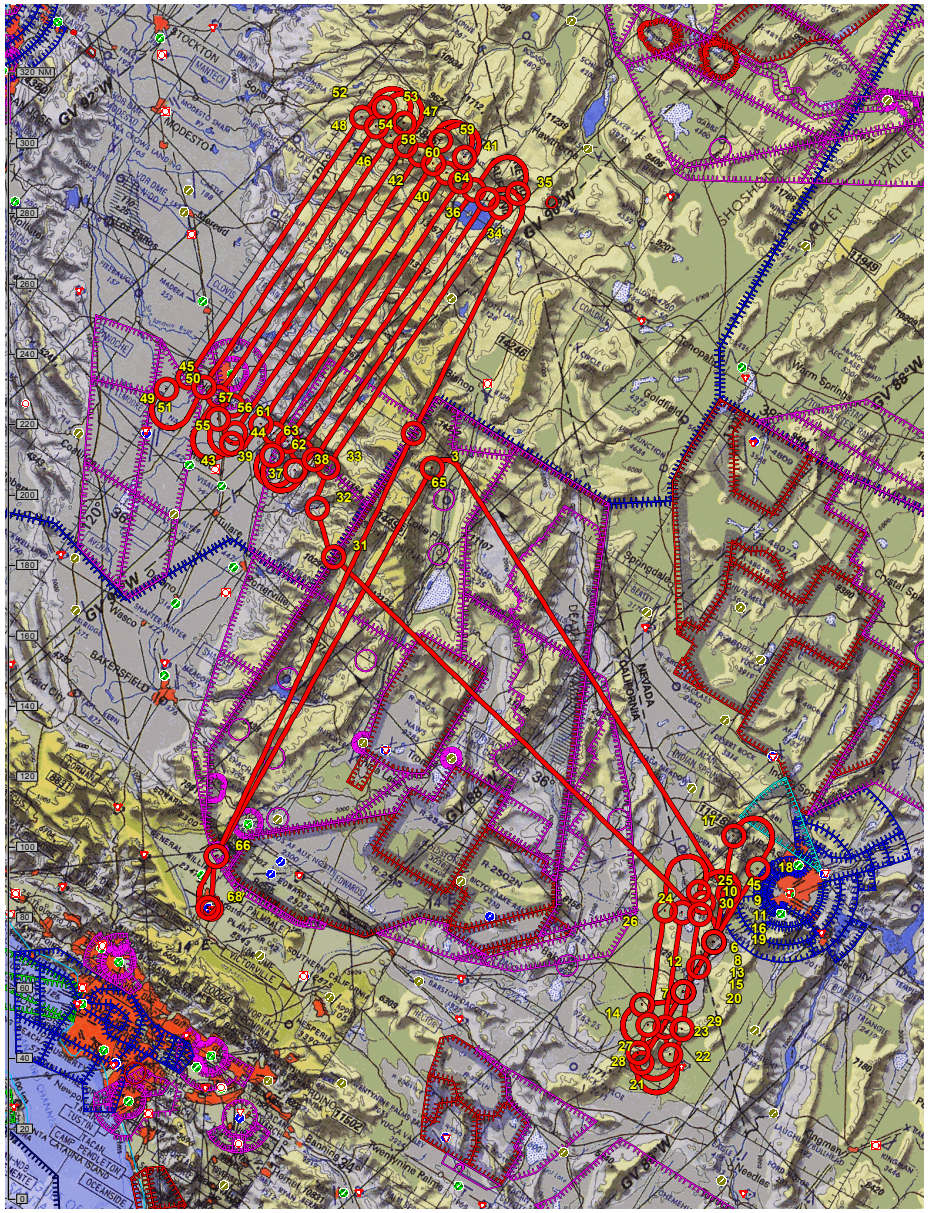
Plus: AirMSPI



May 3, 2013 Yosemite and NEON Box

4.3 hours of Flight Time and ASO Overflight

Plus: NAST-I, SHIS, AirMSPI, & NAST-M



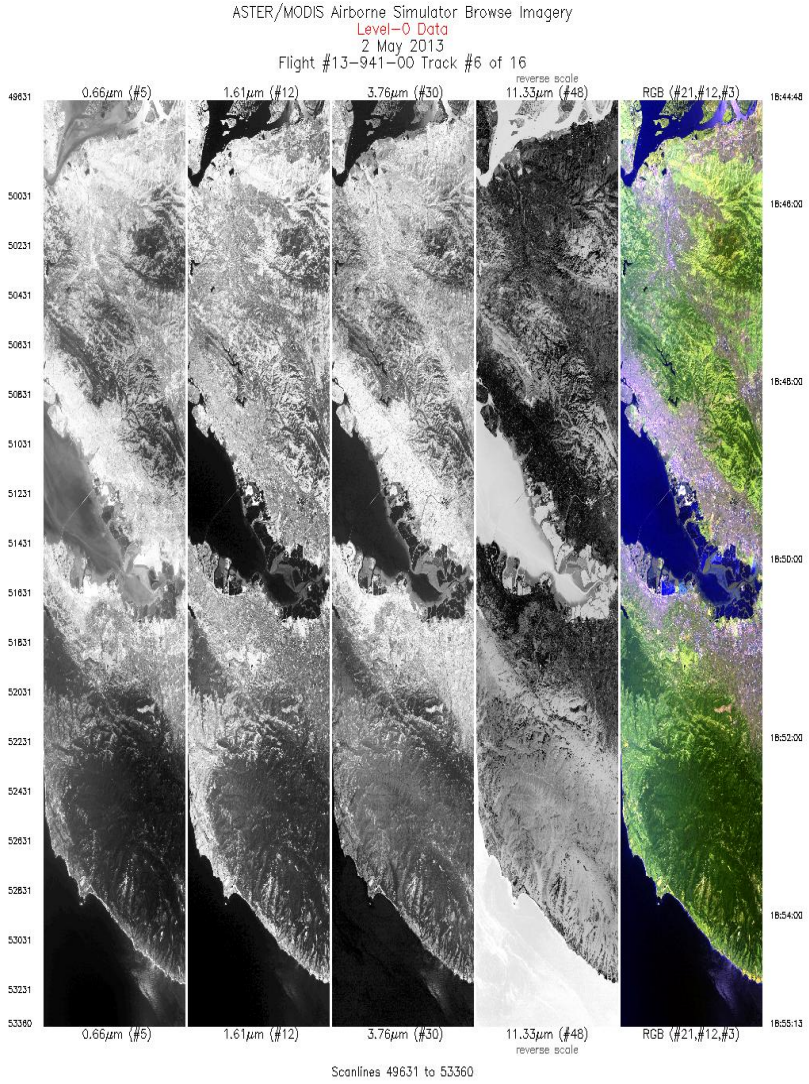
May 2, 2013 – Lake Tahoe Box

Landsat 8 Under-flight over CA Delta and SF Bay

4.4 hour Flight Plus: NAST-I, SHIS, & AirMSPI

AVIRIS Data

MASTER Data

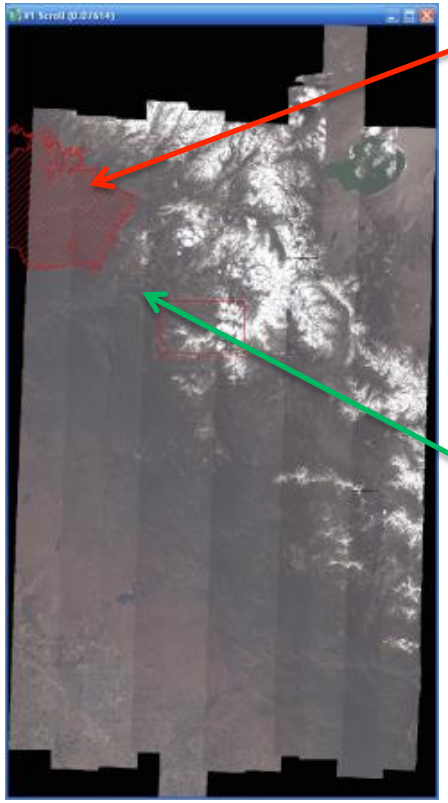


Key Science and Application Event 2013

- Unexpectedly, HyspIRI preparatory campaign has captured a large portion of the RIM fire area before it burned. This highlights the need for HyspIRI-like routine global coverage.

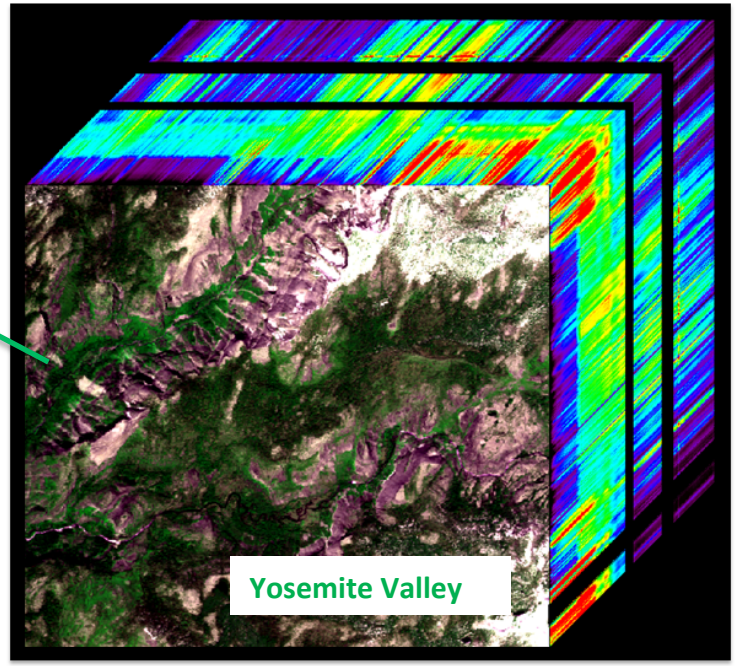
- Fire is a key science and application area for HyspIRI.
  - Fuels: Species-type, dry biomass, and canopy moisture
  - Burning: temperature and emissions
  - Post fire: severity and recovery

VSWIR: Spectroscopy Coverage

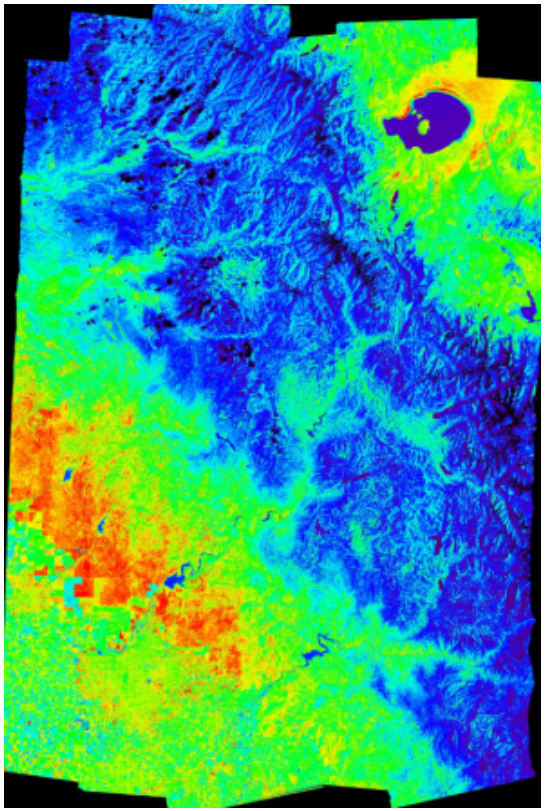


RIM Fire 2 Sep 2013

~250,000 acres or 1000 km^2



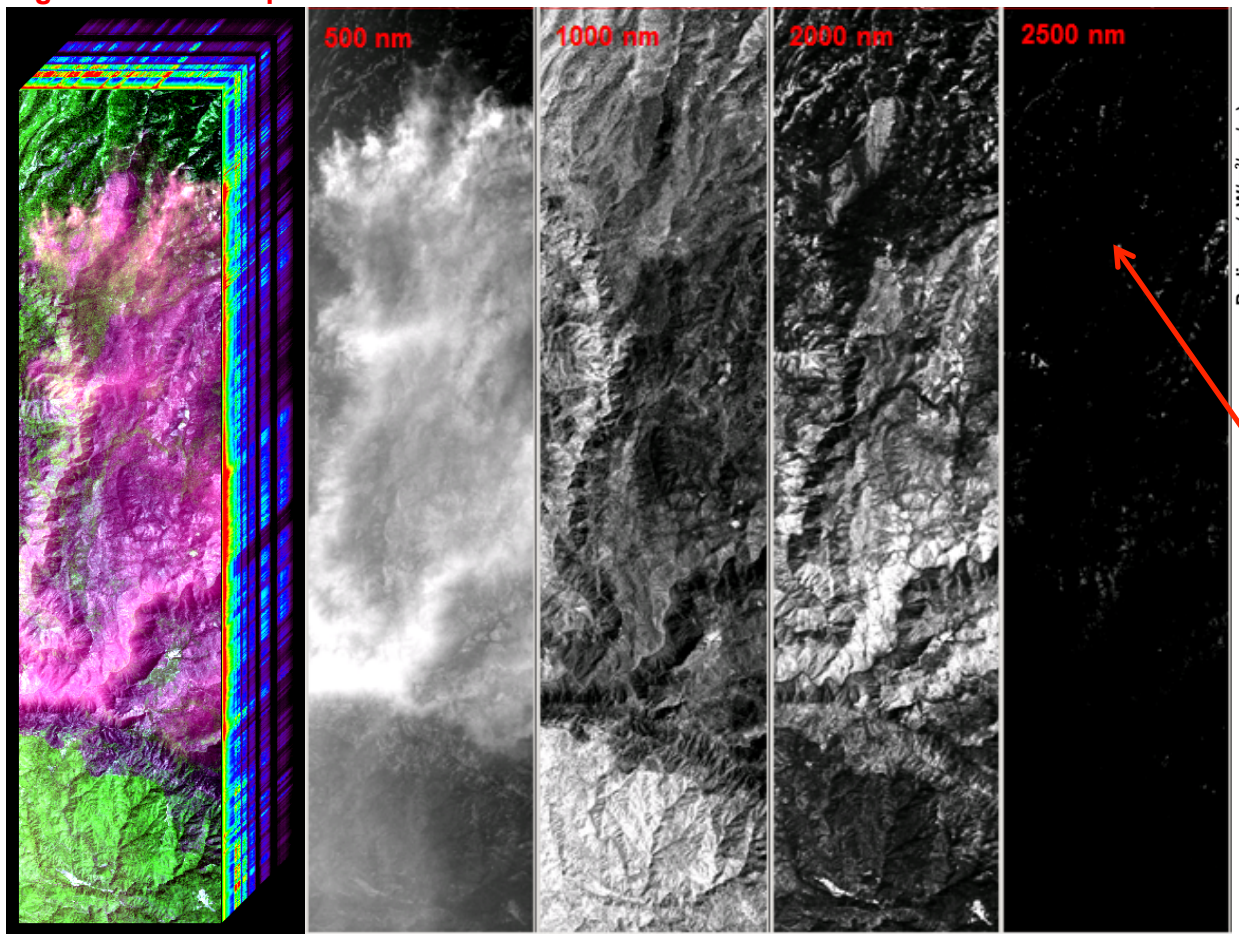
TIR: Land Surface Temperature

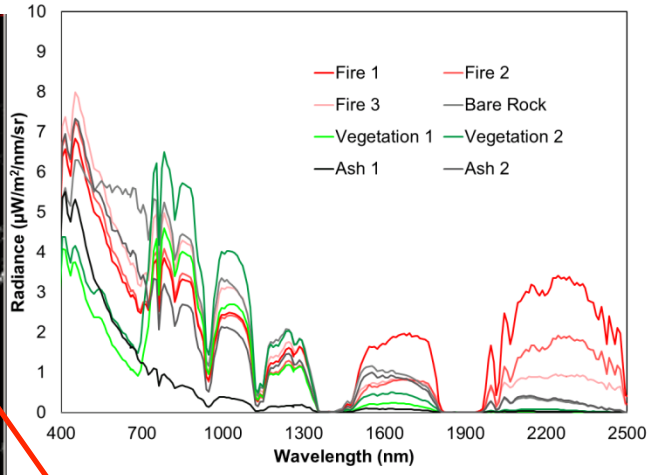


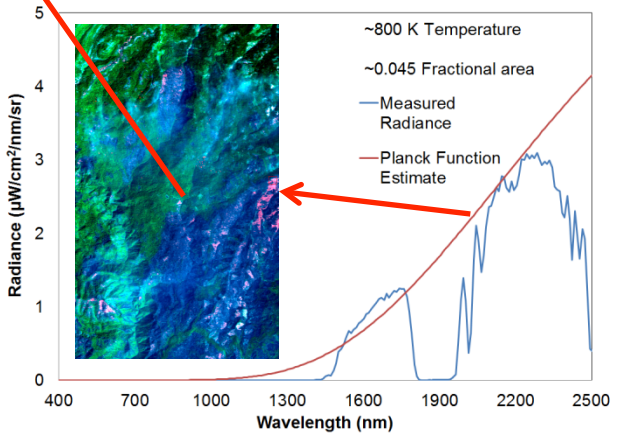
HyspIRI Preparatory Campaign
AVIRIS Rim Fire 130913 Flight Line #5

- As part of the HyspIRI Preparatory Airborne Campaign, AVIRIS obtained VSWIR spectroscopic coverage of the full RIM fire area on the 13th of September.
- VSWIR spectroscopy is used to measure fuels (species-type, water, dry biomass, etc.), hot fire temperature, smoke properties, severity and recovery processes.

Flight line #5 Example

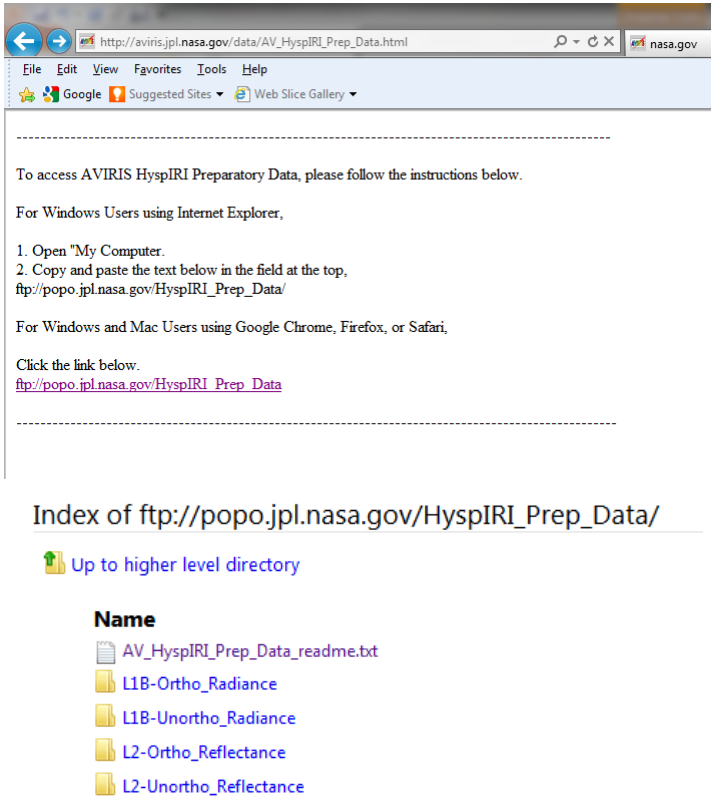






AVIRIS data: http://aviris.jpl.nasa.gov

- Via the quicklook locator
- Via dedicated ftp location
- Via hard disk all data



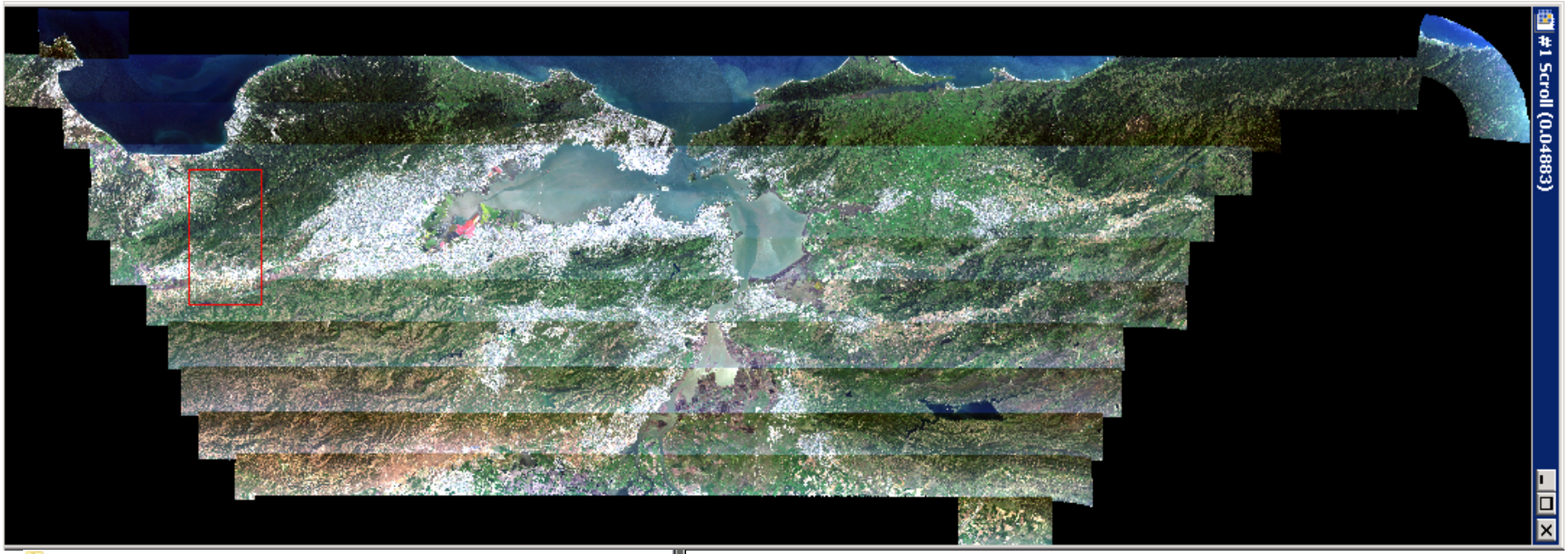
HyspIRI Airborne Preparatory Mission
2014 Nominal Campaign Dates

- Spring Mar 24 – Apr 23
- Early Summer May 27 – June 6
- Late Summer Aug 18 – 29
- Fall Sept 15 – Oct 17

Recent Topics

- Possible investigation of non contemporaneous VSWIR and TIR data sets
- Must continue accommodate the range of actual illumination and observation geometries
  - This is true for all satellite data even LandSat
  - Is true for 20 years of AVIRIS measurement
  - It is expected that there will be boundaries between flight lines in radiance and reflectance.
  - Product algorithms that account for illumination and observation geometries should not have boundaries.
- In data processing we are going to work to add cloud masks
- How best to simulate HyspIRI spatial properties
  - Currently offer the location of every spectrum to allow range of sampling approaches to be used.
  - We will work to support the consensus approach

Illumination and Observation



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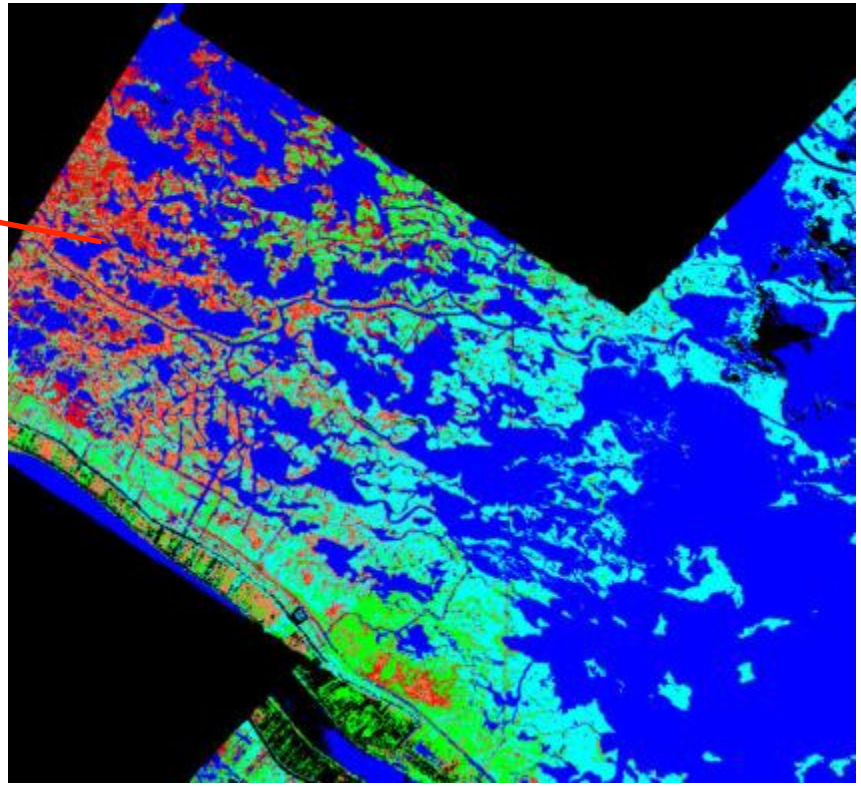
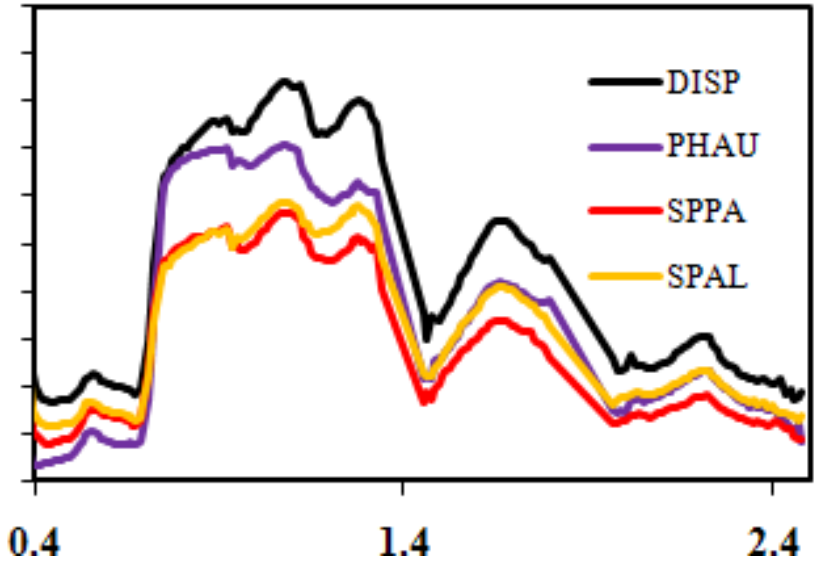
Illumination and Observation

D. Roberts, UCSB



AVIRIS Vegetation Spectra



Vegetation mapped cleanly across scene boundaries

- ***Phragmites (phau)***
- ***Spartina alterniflora (spal)***
- ***Spartina patens (sppa)***
- ***Vigna luteola (vilu)***

Summary

- The HyspIRI preparatory airborne campaign is off to a very strong start with airborne and field work proceeding in 2013
- The data collected to data are available as level 1 and level 2 products for both AVIRIS and Master
- The Autumn 2013 flights will commence as soon as feasible
- We are looking forward to 2014
- The science team is working to address the science and HyspIRI simulation and fulfill both the NASA HyspIRI Mission concept and R&A objectives